SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

APRIL 1900.

GENERAL PHYSICS.

794. *Elasticity of Cast Iron.* **P. A. Thomas.** (Ann. d. Physik, 1. 2. pp. 232–243, Feb., 1900.)—This is a criticism of the methods hitherto adopted for determining the elastic coefficients of iron at various temperatures. The author discusses the sources of error, and points out that temperature has an effect which depends upon the duration of exposure to it. E. E. F.

795. *Elasticity of Wires.* **G. F. C. Searle.** (Phil. Mag. 49. pp. 193–199, Feb., 1900.)—To the ends of a wire are attached parallel rods which are at right angles to the length of the wire. If the wire executes a transverse vibration in the plane of the rods, it is clear that the period depends on the inertia of the various parts (especially of the rods) and on the resistance to bending, which can be calculated from Young's Modulus, and the dimensions of the wire. To the middle of each rod is attached a light hook, the stem of which is at right angles to the plane of the rods. The system is suspended by two strings, one attached to each hook, the plane of the rods being horizontal. If the strings are long enough, the vibration of the system is practically free. Thus the period of the ideal vibration can be approximately determined, and Young's Modulus can be calculated with the aid of the formulæ developed in the paper. To determine the Modulus of Rigidity, one of the rods is clamped in a horizontal position to a suitable support, in such a manner that the wire hangs vertically downwards. The time of vibration of the rod at the bottom, about the axis of the wire, is then determined, and the Modulus is calculated in the usual way.

A table is given showing the results obtained with various wires. In certain cases the relation between the Moduli is such that Poisson's ratio, calculated from the well-known equation, is apparently greater than 0·5. As this, if correct, would imply a negative bulk-modulus, or an increase of volume with increase of hydrostatic pressure, the author infers that the wires in question "are so far from being isotropic that it is improper to apply the theory of isotropic solids to them." A. G.

796. *Froth of Soap Solutions.* **D. H. Hall.** (Roy. Dublin Soc., Proc. 9. pp. 56–59, 1899.)—It is proved experimentally that the liquor derived from the settling of the froth of a soap solution is stronger (if oxidation be avoided) in

soap than the original solution. There must, therefore, be a concentration of the soapy matter after the formation of a film. The author points out that this agrees with a suggestion by Rayleigh, made in connection with the explanation of the stability of soap-bubbles and of the foam of frothing liquids.

A. G.

797. *Diffusion of Gases.* **M. Brillouin.** (Annal. Chim. Phys. 18. pp. 433–448, 1899.)—This paper is mathematical and treats of the theory of the diffusion of gases in the absence of porous partitions. It is shown that, in general, diffusion must be taken into account when the transmission of sound (with its condensations and rarefactions) takes place through a gaseous mixture. This diffusion causes variations in composition of the mixture, which are comparatively great when the densities of the gases forming the mixture are very dissimilar. A. G.

798. *Directive Action of one Crystal on another.* **J. H. Poynting** and **P. L. Gray.** (Roy. Soc., Phil. Trans. 192. pp. 245–256, 1899.)—An account of these experiments has already been published in the Roy. Soc. Proc. (See 1899, Abstract No. 777.) In the present paper a full account is given of the apparatus used and the methods of observation, also of the equations of motion. On the assumed law of force the result implies that the attractions between the two spheres, with distance 5·9 cm. between their centres, do not differ in the parallel and crossed positions by as much as $\frac{1}{1650}$ of the whole attraction. The result found for the semicircular couple implies that the attractions between the two spheres with 5·9 çm. between their centres, with their axes parallel and respectively in like and unlike directions, do not differ by as much as $\frac{1}{2850}$ of the whole attraction.

This limit is large, owing to the want of axial symmetry in the apparatus which produced a semicircular couple. This couple was large, and though the authors attempted to eliminate it by two sets of observations with different azimuths of the larger sphere, they consider that in all probability they failed.

J. J. S.

799. *On a Theorem of Clebsch's.* **P. Saurel.** (Phys. Rev. 9. pp. 300–303, 1899.)—Clebsch's theorem is that every solution of the equations of motion of a vibrating elastic solid can be written in the form—

$$u = \frac{d\mathrm{P}}{dx} + \frac{d\mathrm{W}}{dy} - \frac{d\mathrm{V}}{dz}$$
$$v = \frac{d\mathrm{P}}{dy} + \frac{d\mathrm{U}}{dz} - \frac{d\mathrm{W}}{dx}$$
$$w = \frac{d\mathrm{P}}{dz} + \frac{d\mathrm{V}}{dx} - \frac{d\mathrm{U}}{dy}$$

U, V, W, being three solutions of the equation $\frac{d^2\phi}{dt^2} = a^2\Delta\phi$,

and P being a solution of both the equations $\frac{d^2\mathrm{P}}{dt^2} = b^2\Delta\mathrm{P}$ and—

$$\Delta\mathrm{P} = \frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz}$$

where u, v, w, are the displacements. The present paper simplifies Clebsch's demonstration. S. H. B.

800. *Hydrodynamics and Hertzian Mechanics.* **R. Reiff.** (Ann. d. Physik, 1. 2. pp. 225–231, Feb., 1900.)—Hertz's system of mechanics is defined by the principle that the forces acting upon a system are to be replaced by the coupling of this system with a second system in such a manner that the work performed by the first system is equal to the increase of kinetic energy in the second system. The author shows that in a continuously varying system, such as is presented by a perfect liquid, the method devised by Hertz encounters serious difficulties. In ordinary dynamics, the hydrodynamic pressure appears as the potential of the forces derived from the condition of the preservation of mass. The Hertzian proposal would dispense with this most fundamental and important condition, probably the most firmly established in physics.

E. E. F.

801. *Electrical Theory of Solar Corona.* **A. Souleyre.** (Revue Scientif. 4. pp. 622–627; and 652–657, 1899.)—This is a description (too lengthy to abstract in detail) of the probable connections existing between the variations in the phenomena of solar activity, planetary magnetic and geographical conditions, and interplanetary perturbations, based on the supposition that the electrical forces undoubtedly existent in the solar system constitute the determining factors. One possible cause of the electrification of the solar corona is stated to be the interaction of the currents produced in the sun's atmosphere by variations of temperature, in a similar manner to our terrestrial electrical phenomena, the kinetic energy of motion being partly changed into electrical energy. The varying forms of the coronal structure may be partly due to the constantly varying attractions of the other planets. After showing that the two chief factors in this action will be Jupiter and Saturn, data are given stating the degree of periodicity which would be expected from a consideration of the planetary movements. That produced by Jupiter is strikingly similar to the shorter of the two sun-spot cycles, viz., a little more than eleven years. Saturn would give rise to a periodicity of about twenty-seven years, which of itself is not represented in the solar phenomena as at present known. But if *two* of these twenty-seven yearly periods of Saturn are combined with *five* of the eleven yearly periods of Jupiter, it is evident that a long periodicity of about fifty-five years will result. This is closely in agreement with the *great* sun-spot cycle of fifty-five and a half years.

The author then proceeds to sum up most of the known cases of terrestrial phenomena having a suspected periodicity of similar degree to the sun-spot cycles, giving in the course of it an excellent description of the *zones of interference* produced in the earth's atmosphere. Dealing with the magnetic atmospheric phenomena, he states that the maxima of aurora in *temperate* regions approximately coincide with the minima of auroræ in Arctic regions, and that it is likely the magnetic poles are in such motion as to complete a revolution in six hundred years. The second paper applies similar reasoning to the explanation of variations of latitude and the inequalities of the orbital motion of Mercury and the moon. C. P. B.

802. *Wave-Length of Corona Line.* **C. A. Young.** (Astrophys. Journ. 10. pp. 306–307, 1899.)—As the original author of the misidentification of the corona line with the chromospheric line 1,474 K (λ 5,317), Young replies to the note of Campbell in the October number, announcing the more accurate value. (See 1900, Abstract No. 456.) Young sees no ground to contest the conclusions of Lockyer and Campbell that the true value is near λ 5.303, the photographs obtained during the 1898 eclipse being quite satisfactory

evidence. The reason of the retention of the error was the uncertainty of the duration of totality at the eclipses of 1870 and 1878, leaving Young no time to complete his observations for comparison of the chromospheric and coronal lines. It is noteworthy that at the new wave-length of the corona line λ 5,303, there is no line of the solar spectrum, either dark or bright, nor, so far as is at present known, is there any line of any known terrestrial substance at this position. C. P. B.

803. *Great Sun-Spot, September*, 1898. **J. Fényi.** (Astrophys. Journ. 10. pp. 333–336, 1899.)—The article describes the phenomena observed during the period of visibility of this spot, one of the largest that has been seen on the solar surface. The widespread prevalence of auroræ and magnetic disturbances were specially noticeable. Spectroscopic determinations of the distortion of lines showed the matter in and surrounding the spot to have velocities as high as 470 km. per second. C. P. B.

804. *Solar Eclipse Problems.* **G. E. Hale.** (Astrophys. Journ. 11. pp. 47–66, Jan., 1900.)—The author gives a short summary of the most important branches of solar physics which it is advisable should receive attention at subsequent total eclipses. These include: (1) Naked-eye drawings of corona; (2) Drawings at the telescope; (3) Colour of corona and prominences; (4) Small scale photographs of corona; (5) Photographs of corona during partial phase before and after totality; (6) Photographic search for possible intra-mercurial planets; (7) Large-scale photographs of corona and prominences; (8) Distribution of *coronium*; (9) More accurate value for wave length of green corona line; (10) Photographs of spectrum of chromosphere; (11) Photographs of spectrum of corona; (12) Heat radiation of corona. C. P. B.

805. *Escape of Gases from Planetary Atmospheres.* **S. R. Cook.** (Astrophys. Journ. 11. pp. 36–43, Jan., 1900.)—The author extends the work of G. Johnstone Stoney (see Astro-Phys. Journ. 7. p. 25, Jan., 1898; Trans. Roy. Dublin Soc. vi. part 13), by determining, with the aid of the kinetic theory, the relative number of molecules which would have a velocity sufficient to enable them to escape from the earth or planet, assuming there be no retarding media. This velocity he designates the *critical velocity* of the gas. The result indicates that the amount by which the various planetary atmospheres are being diminished is exceedingly small. The conditions have been computed under four different sets of assumptions, based on the observations of Stoney, Cleveland Abbe, and Ferrel. C. P. B.

806. *Earthquake of Balikesri (Asia M.) of September* 14, 1896. **G. Agamennone.** (Accad. Lincei Atti, 8 pp. 365–368, 1899.)—Balikesri is the only place known where the earthquake did any damage, the intensity being 7–8°, on the scale De Rossi-Forel. It is very probable that the epicentre was somewhere about this locality, the latitude being 40° N. and the longitude 28° E. of Greenwich. The author points out that there appear to have been two seismic waves. By comparing the indications of the instruments at Padua and Nicolayef with those at Constantinople he determines the velocity of the more rapid waves to be about 8⅓ kilometres per second. The rapid waves are probably longitudinal. The slower waves are probably transversal, and are due to the surface of the earth moving up and down in a mode analogous to the waves of the sea; the velocity of their maximum phase is about 2½ kilometres per second. A. G.

807. *Roman Earthquake of July* 19, 1899. **P. Tacchini.** (Accad. Lincei Atti, 8. pp. 291–296, 1899.)—The principal shock at Rome was of intensity VII.–VIII., on the scale De Rossi-Forel. According to Cancani the epicentre was near Frascati, Grottaferrata, and Marino.

The table given below indicates the velocity of the leading seismic waves.

Distance from epicentre.	Place.	Time of beginning (t.m.C.E.).	Apparent velocity per second.
		h. m. s.	
20 km.	Rome	14 18 55±3	...
160 „	Ischia	14 19 37	3·33 km.
170 „	Portici (Naples)	14 19 21	5·00 „
250 „	Quarto (Florence)	14 19 26±2	7·42 „
400 „	Padua	14 20 7	5·28 „
490 „	Lubiana (Carniola)	14 21 58	2·57 „
520 „	Catania	14 21 2	3·94 „

It is pointed out that the differences can be partly attributed to the unequal sensibilities of the instruments. If the assumption be made that some of the instruments were too coarse to indicate the leading waves, the following slightly different values for the velocity are obtained : 4·00 (Ischia), 8·82 (Portici), 9·58 (Quarto), 5·85 (Padua), 2·67 (Lubiana), 4·17 (Catania).

So far as is known there were no preliminary shocks, and no precursory phenomena. A. G.

808. *Earthquake in Emilia, March* 4–5, 1899. **G. Agamennone.** (Accad. Lincei Atti, 8. pp. 321–326, 1899.)—The epicentre was at lat. N. 44½°, long. 10⅓° E. of Greenwich. The maximum intensity was VIII. on the scale De Rossi-Forel. The author mentions the difficulty of obtaining reliable data for determinations of the velocity of the seismic waves ; applying the method of least squares, he obtains a mean value of 2,900 metres per second. It is of interest to compare this mean with the values determined from limited data, more or less reliable. The velocity from Padua to Rome comes out to be 2,600 metres per second, from Florence to Rome 4,100 metres per second. The first value is perhaps too small, because the instrument at Rome was less sensitive than that at Padua ; whilst the second value is perhaps too high, because the instrument at Rome was more sensitive than that at Florence. A calculation of the velocity of maximum phase would lead to results still more erratic. A. G.

LIGHT.

809. *Refractive and Magnetic Rotatory Powers of Aromatic Hydrocarbons and Refractive Powers of Mixtures.* **W. H. Perkin.** (Chem. Soc., Proc. 15. pp. 237–238. Discussion, p. 238, 1899.)—The author's results lead to the following conclusions: Replacement of a hydrogen atom by a methyl group gives a larger value for the refractive power when the replacement occurs in the nucleus than when it takes place outside. In the latter case the results are higher than the calculated, but the difference tends to vanish as the distance of the substituent group from the nucleus increases. With the magnetic rotation, on the other hand, a change in composition of CH_2 produces a smaller increase when in the nucleus than when outside it. These results hold for 4 and probably for the whole 6 replacements. Measurements of the refractive powers of various mixtures of fatty as well as aromatic compounds show that when the two constituents of a mixture have very widely different indices of refraction the specific or molecular refraction is considerably lower than the calculated value, but that when the separate indices are nearly equal the calculated and experimental numbers show good agreement. T. H. P.

810. *Great Refracting Telescope, Paris,* 1900. (Scientific American, 81. pp. 298–299, 1899.)—This is an interesting description of the large refractor being constructed by Gautier for the Paris Exhibition of 1900. Full details are given of the apparatus for substituting either a visual or photographic lens. The objectives are 4·1 feet in diameter, with a focal length of about 197 feet. These are fed with light from the celestial bodies by means of a siderostat, the mirror of which is 6·56 feet in diameter. On account of the uncertain weather in Paris it is probable that the instrument will be set up at some distance from the city. C. P. B.

811. *Calibration of Slit in Spectro-photometry.* **E. V. Capps.** (Astrophys. Journ. 11. pp. 25–35, Jan., 1900.)—This article deals first with the description of the intensity curve of the spectrum, proceeding to describe the new spectro-photometer designed by G. B. Brace, of Nebraska University, with which the work has been performed. Great difficulty was found in obtaining a source of light which should at once be constant, uniform, and of great intensity. The form finally adopted was a specially made incandescent lamp, having a flat filament about 12 mm. wide, which was placed about 12 cm. from the slit. The artificial variation of one of the sources of light was obtained by a notched rotating sector, the proportions of which were such that the intensity was diminished one-eighth of the whole for every advance of one notch. Curves and tables are given of the settings obtained, showing that in the case of a crown glass prism the intensity increases faster than the width of the slit in the red and blue, but slower in the yellow. Using a flint glass prism the general result is the same, but not so pronounced in degree. From the experiments the following conclusions may be drawn :—

(1) The direct-ratio law holds for only two points in the spectrum, corresponding approximately to wave-lengths λ 6,200 and λ 5,700. (2) The variation is greatest in the red and blue regions of the spectrum, and least

and of opposite sign in the yellow. (3) It increases as the slit increases in width. (4) It decreases as the refractive power is increased. (5) It is practically independent of the relation of the two light sources provided they do not differ by more than 50 per cent. in intensity. C. P. B.

812. *Colour Sensations in Terms of Luminosity.* **W. de W. Abney.** (Roy. Soc., Proc. 65. pp. 282–283, 1899; and Roy. Soc., Phil. Trans. 193. pp. 259–287, 1899.)—This paper deals with a determination of the colour sensations based on the Young theory by means of measures of the luminosity of the three different colour components in a mixed light which matches white. At the red end of the spectrum there is only one colour extending to near C, and there is no mixture of other colours which will match it, however selected. At the violet end of the spectrum, from the extreme violet to near G, the same homogeneity of light exists, but it is apparently due to the stimulation of the two sensations, a red and a blue sensation, the latter never being felt unmixed with any other. By trial it was found that close to the blue lithium line the blue sensation was to be found unmixed with any other sensation except white. The complementary colour to the red in the spectrum gave a position in which the green and blue sensations were present in the right proportions to make white, and a point nearer the red gave a point in which the red and blue sensations were present in such proportions as found in white, but there was an excess of green sensation. The red, blue, and green sensations were thus located. The position in the spectrum of the yellow colour complementary to the violet was also found. The colour of bichromate of potash was matched by using a pure red and the last-named green. To make the match, white had to be added to bichromate colour. A certain small percentage of white was found to exist in the light transmitted through a bichromate solution with which the match was made, and this percentage and the added white being deducted from the green used gave the luminosity of the pure green sensation existing in the spectrum colour which matched the bichromate. Knowing the percentage composition in luminosity of the two sensations at this point, the luminosity of the three sensations in white was determined by matching the bichromate colour with the yellow (complementary to the violet) and the pure red colour sensation. From this equation and from the sensation equation of the bichromate colour already found, the composition of the yellow was determined. By matching white with a mixture of the yellow and the violet, the sensation equation to white was determined. The other colours of the spectrum were then used in forming white, and from their luminosity equations their percentage compositions in sensations were calculated. The results found from the percentage curves were applied to various spectrum luminosity curves and the sensation curves obtained. Attention is called to the results deduced from these curves and from other curves obtained from them, and the difference between Koenig's determination and that of the author is pointed out. J. J. S.

813. *Instantaneous Photography.* **G. Sigriste.** (Comptes Rendus, 130. pp. 82–84, Jan. 8, 1900.)—The shutters used for instantaneous exposure are of two types. Those attached to the lens produce an even increase and decrease of the illumination over the whole picture, but their efficiency is low, and they give rise to diffraction phenomena when the exposure is very short. The only thoroughly scientific shutter is the second type, consisting of a slit moving rapidly across the sensitive plate itself. The transition between darkness and exposure is instantaneous, and hence the efficiency is a maximum.

But for a good result the interval between the shutter and the plate must be not over 0·1 mm., and the edges of the slit must be sharp and carefully bevelled so as to exclude disturbance by reflection. E. E. F.

814. *Photographic Image in Stratified State.* **A. Trillat.** (Comptes Rendus, 130. pp. 170–172, Jan. 22, 1900.)—The author has succeeded in depositing the amorphous silver of a photographic image in a stratified state.

The plate is polished and hardened and exposed to the action of the vapour of nitric acid. This dissolves the silver, which remains in the gelatine in a colloidal condition. It is then precipitated by exposure of the plate to a stream of sulphuretted hydrogen, and assumes a stratified form, showing iridescent colours. There is no relation apparent between the colours obtained and the real colours of the object photographed, but the colours seem to vary with the thickness of the silver deposit, and the author was able to artificially localise colours corresponding to the actual colours. G. H. B.

815. *Law of Reciprocity for Bromide of Silver Gelatine.* **K. Schwarzschild.** (Astrophys. Journ. 11. pp. 89–99, Jan., 1900; Photographische Correspondenz, 1899.)—The law of reciprocity states that the degree of blackening is the same when the product of the intensity of the light, I, and the time of exposure, t, is constant. Abney and others have found deviations from this law, and the author's experiments confirm these. He obtains the formula $I \times t^{0.86} =$ constant for constant blackening, employing Schleussner's plates, and varying the exposures from 3 to 5,000 seconds and the intensity of light from one to a thousandfold.

If the exposure, instead of being continuous, is interrupted, the total time of exposure remaining however the same, the resulting blackening is diminished. In the experiments, which are fully described in the paper, the exposure was made through a rotating disc with one or more slits, and each exposure was interrupted a considerable number of times. The diminution of blackening due to intermittence depends on two quantities; it increases with the ratio of the time of interruption to that of exposure, and it increases as the quantity of light reaching the plate during each single exposure diminishes. If this quantity exceeds what the author terms its limiting value, *i.e.*, a value which of itself produces a barely appreciable blackening, the effect of the intermittence is inappreciable, whatever the total length of exposure or the intensity of the light, but below the limiting value the smaller the quantity of light the greater is the effect of the intermittence. In one case, when the time of interruption was twenty-three times as long as that of exposure, the diminution of blackening amounted to 40 per cent., but when the times were equal the effect was very small. No appreciable influence is due to the degree of blackening and total length of the exposure, or to the luminous intensity. G. H. B.

816. *Decomposition of Luminous Vibrations.* **C. Fabry.** (Comptes Rendus, 130. pp. 238–241, Jan. 29, 1900.)—If

$$x = \mathrm{F}(t)$$

be the law of a luminous vibration, the function F can, under certain conditions as to continuity, be represented by a Fourier integral,

$$\mathrm{F}(t) = \int_0^\infty \phi(q) \sin 2\pi(qt - a) dq,$$

and we may then say that the movement represented by the first equation is the superposition of an infinity of pendular movements, the movement of frequency q having the amplitude $\phi(q)$ and the phase α. The distribution of energy in the spectrum will then be represented as a function of the frequency, by

$$W = [\phi(q)]^2.$$

H. Poincaré has raised the objection that the above integral represents the function F for all values of t, even for periods after the extinction of the source. This sounds paradoxical, but it is nevertheless true, and a grating would continue to show a spectrum for an indefinitely long time after the source had been extinguished if it were as perfect as the theory demands, *i.e.*, if the number of lines were infinite and its power of resolution were perfect. The infinite prolongation of the radiation would imply an infinite supply of energy, but this also is not surprising, since the incident wave-train would have to be of infinite extent. Thus the objection raised by Poincaré, while theoretically correct, fails to impair the practical usefulness of Gouy's theory.

E. E. F.

817. *Constitution of White Light.* **E. Carvallo.** (Comptes Rendus, 130. pp. 79–82, Jan. 8, 1900.)—The author throws doubt on the supposition that white light is due to a damped vibration. This is not in agreement with the observations of Morton and of Langley with regard to the distribution of intensity in the spectrum. If white light were due to a damped vibration of the type $e^{-kt}\sin ht$, the grating spectrum would not give different colours but white light over its whole area. The fault of the accepted theory lies in its neglect of the intensities of radiation, which in isolated regions are insensible to the eye, but which become of notable proportions when the formation of a Fourier series is in question.

E. E. F.

818. *White Light and Röntgen Rays.* **E. Carvallo.** (Comptes Rendus, 130. pp. 130–132, Jan. 15, 1900.)—The effectiveness of gratings in giving to each colour a definite and constant intensity for any given source of light, without the various radiations interfering with each other, owing to the coherent differences of phase implied in Fourier's formulæ, points out the independence, and, so to speak, the individuality of each radiation. If, for instance, the two D lines of sodium arise from the decomposition of a single movement of invariable form, they must have the same difference of phase at the beginning of each disturbance. In that case they will produce beats by their interference. If, on the other hand, they are due to two vibrations which have an independent origin, no regular link will exist between the phases of the two components. The decision of this question by experiment appears very difficult, but with the aid of a revolving mirror it might be possible in the case of two lines much closer together. The author inclines to the belief that Röntgen rays are due to a non-periodic disturbance. This belief is confirmed by the absence of refraction and diffraction, for the author has previously shown that the front of every disturbance in the ether is propagated in any medium with the velocity of light in space, but that the disturbance is deformed in the course of its propagation. Even in periodic disturbances this is the case, but for these the periodicity is re-established in every point at the end of a certain time after the wave-front has passed the point. Hence the apparent slowness of propagation and refraction. These phenomena are due solely to periodicity, and Röntgen rays do not exhibit

refraction on account of their lack of periodicity. Hence their nature—that is, the form of the disturbance—must be modified as they penetrate growth into bodies, and the varying character of the secondary radiation studied by Sagnac is accounted for. E. E. F.

819. *Constitution of White Light.* **Gouy.** (Comptes Rendus, 130. pp. 241–244, Jan. 29, 1900.)—The author criticises Carvallo's objections to regarding white light as composed of damped oscillations. (See the two preceding Abstracts.) The simple oscillations which together are supposed to make up white light are purely fictitious, but they enable us to calculate the total energy spent between two given epochs. Carvallo's contention that if white light were composed of damped oscillations of the type $e^{-kt}\sin ht$, a grating would only yield white light from a white source, is vitiated by the fact that it involves an integration over the whole of time, which does not enter into practical physics. Damped oscillations form a workable hypothesis, but not the only possible hypothesis. E. E. F.

820. *Optical Problems.* **C. Godfrey.** (Roy. Soc., Proc. 65. pp. 318–319, 1899.)—The author points out that the solution usually given of the differential equation which governs the propagation of plane polarised light is applicable only to a train of waves without beginning or end, whereas in nature he says no radiation has this property. He suggests a solution by means of Fourier's integrals, thus—

$$f(t)=\int_0^\infty (\mathrm{C}\cos ut+\mathrm{S}\sin ut)\,du,$$

where—

$$\mathrm{C}=\frac{1}{\pi}\int_{-\infty}^{\infty} f(v)\cos uv\,dv,$$

$$\mathrm{S}=\frac{1}{\pi}\int_{-\infty}^{\infty} f(v)\sin uv\,dv,$$

so that $f(t)$ is the sum of simple circular functions of time. It is proved that this process is legitimate when $f(t)$ is such a function of time as occurs in physical problems. The method is applied to various cases of radiation. S. H. B.

821. *Magneto-Optic Rotation.* **J. Larmor.** (Cambridge Phil. Soc., Proc. 10. pp. 181–182, 1899.)—When in a material molecule there exists an independently vibrating group of ions or electrons, for all of which the ratio e/m of electric charge to inertia is the same, then the influence of a magnetic field H on the motions of this group is precisely the same as that of a rotation with angular velocity ω, equal to $\frac{1}{2}e\mathrm{H}/m\mathrm{C}^2$, imposed on the group around the axis of the field, on the hypothesis that the extraneous forces acting on the ions are symmetrical with respect to this axis. (Phil. Mag., Dec., 1897.) This result involves the main features of the Zeeman effect; it requires that the separations of the doublets representing the spectral lines arising from such a group must all be equal when measured in difference of frequency, or be inversely as the square of the wave-length in vacuum when measured in difference of wave-length, a relation which Preston has recently found to obtain for the natural series of lines in ordinary spectra.

The author here points out that it is possible to deduce the Faraday effect from the Zeeman effect by general reasoning as regards any medium in which the optical dispersion is mainly controlled by a series of absorption bands for which the Zeeman effect obeys the above law, without its being necessary to introduce any special dynamical hypothesis. For this law ensures that the effect of the magnetic field on the periods of the corresponding free vibrations of the molecules is the same as that of a bodily rotation, say with angular velocity ω, round its axis; while the complete circular polarisations of the Zeeman doublets, viewed in the direction of the axis, show that their states of vibration are symmetrical with respect to that axis. Thus, Ω being the angular velocity of the displacement vector in a train of circularly polarised waves traversing the medium along its axis, the state of synchronous vibration which it excites in the molecules will have exactly the same formal relation to this train when the magnetic field is off as it would have to a train with the very slightly different angular velocity $\Omega \pm \omega$ when the magnetic field is on, the sign being different according as the train is right-handed or left-handed. Now change of this angular velocity Ω means change of period of the light: thus the propagation of a circularly polarised wave-train, when the field is on, is identical with that of the same wave-train when the period is altered by its being carried round with angular velocity $\pm \omega$, and there is no influencing magnetic field. This last result has been employed by Becquerel as a single hypothesis from which to deduce quantitatively both the Zeeman effect and the Faraday effect, and thus correlate them. (See 1898, Abstract No. 115.)

The preceding argument forms a general dynamical justification of this hypothesis for the case of all media in which the ordinary gradient of dispersion is mainly controlled by one or more powerful absorption bands beyond the visible spectra, for which the Zeeman constants are the same; it also shows that Becquerel's hypothesis has an approximate validity when these constants are nearly the same for all the effective bands. In the immediate neighbourhood of any single band the dispersion is anomalous, and is controlled practically by that band alone: the application will then be exact, and in Becquerel's hands it has given a complete account of the excessive and anomalous Faraday rotation first observed by Macaluso and Corbino in sodium vapour for light adjacent to the D lines. These simple general conclusions are consistent with the results of the more special dynamical investigations by Fitzgerald and Voigt.

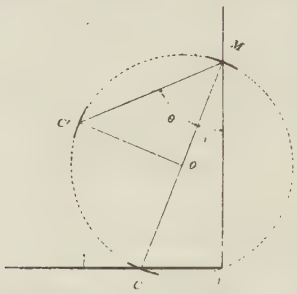
[For a further account of the subject of this paper, and abstracts of some of the papers quoted, reference may be made to Abstracts Nos. 115–120, and Nos. 755–759 (1898); also Nos. 246 and 422–427 (1899).] J. J. S.

822. *Theory of Magneto-Optic Effects.* **W. Voigt.** (Ann. d. Physik, 1. 2. pp. 389–398, Feb., 1900.)—The author extends his theory, which was hitherto limited to waves propagated parallel or normal to the magnetic lines of force, by allowing the waves to be propagated in any direction. The complete final formulæ are very complicated. Their discussion is therefore limited to the two practically most important cases, where the line investigated belongs to a region of nearly vanishing absorption, or lies in the neighbourhood of a sharp absorption band. The first case yields formulæ for a kind of generalised Faraday effect, the latter gives those for the general inverse Zeeman effect. The latter may also be applied to the absorption bands themselves, and they thus, with the aid of Kirchhoff's theorem, yield the laws of the direct

Zeeman effect in any direction of propagation. The differences in velocity, absorption, and ellipticity encountered in passing from a sharp absorption band to a region of vanishing absorption, are remarkably great. E. E. F.

823. *Arc Spectrum of Vanadium.* **B. Hasselberg.** (Astrophys. Journ. 10. pp. 343–361, 1899 ; 11. pp. 67–88, Jan., 1900 ; Köngl. Svenska. Vetenskaps-Akademiens Handlingar, 32. 2. 1899.)—This is the fifth of a series of investigations the author is undertaking with a view of placing the spectroscopy of the metallic elements on a substantial basis. The spectra are taken with a plane diffraction grating, and much of the paper is devoted to the discussion of the probable impurities. Tables are given showing the wave-lengths and intensities of about 450 lines which the author concludes are certainly due to vanadium. The measuring apparatus and method of reduction by interpolation formulæ are also fully described. C. P. B.

824. *Use of Concave Gratings.* **G. B. Rizzo.** (Accad. Sci. Torino, Atti, 34. 15*a*, pp. 794–799, 1898–99.)—Instead of Rowland's normal position of the



telescope or sensitive plate at C (see diagram), the author places it at C′, in a position such that $\sin\theta = 2\sin i$. He thus obtains a normal spectrum which, while as regular as that of Rowland, is considerably more brilliant. E. E. F.

825. *Kinetics of a Line Spectrum.* **E. Riecke.** (Ann. d. Physik, 1. 2. pp. 399–413, Feb., 1900.)—It is usually assumed that the luminous molecules of a gas are composed of a number of vibrating atoms, and that the vibrations of the atoms, or rather of the ions attached to them, produce the light-waves in the ether. If the number of such ions is finite, the condition of the vibrating molecule will be defined by a finite number of general co-ordinates. This conclusion is, however, rendered doubtful by the existence of the multiple series of vibration numbers discovered by Kayser and Runge, which may be represented by formulæ of the type $a - \frac{b}{n^2} - \frac{c}{n^4}$. If these series consist of an infinite number of superimposed partials, a molecule with a finite number of degrees of freedom does not suffice for their production. The author endeavours to find a mathematically correct and an easily imagined system capable of explaining the series of oscillations. The system has the general nature of a set of concentric rings. E. E. F.

826. *New Magneto-Optic Effect.* **R. Dongier.** (Comptes Rendus, 130. pp. 244–245, Jan. 29, 1900.)—The author has discovered a partial polarisation of the light emitted by vacuum tubes under the influence of a magnetic field. It is best observed in the case of the red rays emitted by hydrogen under the

spark discharge. With a magnetic field of 4,000 units acting at right angles to the axis of the tube, an ordinary spectroscope only shows a diminution in the intensity of the radiation. But a Savart polariscope reveals the fact that the radiation has become partially polarised. The light emitted in a plane normal to the axis of the tube differs according to its azimuth. The greatest proportion of polarised light is found in a direction normal to both the tube and the field. There are two such directions, and they again differ in optical properties among themselves. That direction shows the maximum of polarised light, which is such that the observer can, by a right-handed rotation of 90°, bring the vector representing the magnetic field into coincidence with the vector of the electric field inside the tube. The fringes observed can in fact be made to appear and disappear by commutating either the current or the field. A red glass should be used to intercept the other rays. Similar effects, though less well marked, are observed in nitrogen, carbonic acid, argon, and chlorine. E. E. F.

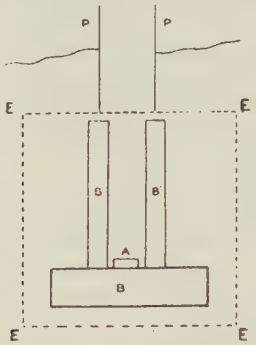
827. *Absorption of Röntgen Rays by Aqueous Solutions of Metallic Salts.* **Blythswood** and **E. W. Marchant.** (Roy. Soc., Proc. 65. pp. 413–428, 1899.)—The absorption produced by normal aqueous solutions of metallic salts having the same acid radicle increases with increase of atomic weight of the base. Metals belonging to the alkali group are not very absorbent, neither are those belonging to the Ca, Sr, and Ba groups, their atomic weight being taken into consideration. Bromides and iodides of the metals are all highly absorbent. With the three common acids the order of increasing absorptive power is nitrate, chloride, sulphate. The absorption produced by a salt is dependent mainly on the atomic weight of its constituents. The amount of absorption produced by a given thickness of a solution of a metallic salt is not proportional to the amount of salt in solution, but appears to follow approximately a logarithmic law. The amount of absorption varies logarithmically with the thickness of the solution traversed by the rays, and the percentage absorption may be represented by an equation of the form $r = \log(\lambda t + \mu)$, where λ is a constant, depending on the nature of the solution and on the penetrative power of the X-rays, and t is the thickness of the solution traversed. For the apparatus used the value of μ would seem to be negligible. A. D.

828. *Velocity of Röntgen Rays.* **B. Brunhes.** (Comptes Rendus, 130. pp. 127–130, Jan. 15, 1900.)—By a method based on the action of Röntgen rays on explosive potentials at different distances, the author finds that Röntgen rays have a definite velocity of the order of the velocity of light. A. D.

829. *Radiography with Three-Phase Currents.* **Delézinier.** (Comptes Rendus, 130. pp. 169–170, Jan. 22, 1900.)—The author has done some further work with the system of three-phase radiography devised by him. (See 1900, Abstract No. 470.) He has found that the connections between the electrodes of the Röntgen tube and the two terminals of the induction coil may be reversed without altering the efficiency of the tube With the aid of a Wehnelt interrupter and an induction coil any three-phase lighting circuit may be used for radiography. E. E. F.

830. *Magnetic Deflection of Becquerel Rays.* **P. Curie.** (Comptes Rendus, 130. pp. 73–76, Jan. 8, 1900.)—The rays emitted by radio-active substances

show a very different behaviour in a magnetic field in accordance with the mode of preparation of the substance. The author studies the magnetic deflection of various rays quantitatively by means of the apparatus shown in the diagram. BB'B'' are blocks of lead containing the radiant substance A. PP' are two plates kept at a difference of potential of 500 volts. Ordinarily the rays proceeding from A pass between the plates and cause a measurable current to pass between the plates. But when a magnetic field is established at right angles to the plane of the paper over the region EEEE the rays are



generally deflected and absorbed by the lead masses, so that they no longer ionise the air between P and P'. Experiments with various samples of radio-active barium carbonate show that the rays are deflected to a very different extent. It is found that those rays which have the greatest penetrative power are most easily deflected by a magnet. The rays which are not deflected penetrate the air at ordinary pressure only to a distance of 6 or 7 cm. The relation between penetration and magnetic deflection marks a fundamental difference from the Röntgen rays. E. E. F.

831. *Penetration of Becquerel Rays.* **Mme. S. Curie.** (Comptes Rendus, 130. pp. 76–79, Jan. 8, 1900.)—Becquerel rays are more easily absorbed when they have already penetrated an absorbing layer than when they have not. This is due to the fact that the less penetrative rays are absorbed in the first absorptive layers. An aluminium disc will absorb a certain proportion of polonium rays. A second aluminium disc will absorb an even greater proportion of the remainder. Polonium rays are not deflected by a magnet, and are propagated in straight lines. E. E. F.

832. *Manganese in Fluorescent Screens.* **J. R. Mourelo.** (Comptes Rendus, 129. pp. 1236–1238, Dec. 26, 1899.)—Several recipes are given for making brilliant fluorescent screens containing manganese as an active substance. In one of them, 100 parts of $SrCO_3$ are mixed with 30 of sulphur and 0·2 of $MnSO_4$. The mixture is kept three hours at a red heat in an earthenware crucible. The resulting sulphide is nearly white, very hard, and shows a bright, greenish-yellow fluorescence. A still better product is obtained by adding to 100 gms. $SrCO_3$ 50 cc. of water containing 2 gms. of dried Na_2CO_3 and 0·5 gm. of fused NaCl. The mixture is desiccated and calcined, and 30 gms. of sulphur and 0·2 gm. $MnSO_4$ are added to the product. The subsequent heating produces a sulphide which only requires a very short exposure. Freshly prepared manganese carbonate is even better than the sulphate. All the manganese screens are greenish-yellow, while the bismuth screens are greenish-blue. (See also 1899, Abstract No. 1145.) E. E. F.

833. *Fluorescent Screens.* **J. Precht.** (Ann. d. Physik, 1. 2. pp. 420–423, Feb., 1900.)—The author studies the modifications of the radioscopic pictures observed immediately after commencing work. Zinc sulphide screens at first show the hand as solid, and the bones only gradually appear. The time varies from a few seconds to a minute, and is, generally speaking, the shorter the higher the spark potential, and the "harder" the tube. Shorter intervals are obtained with barium platinocyanide screens, and these have the advantage that the fluorescence ceases with the illumination. The author has not been able to prove the existence of any chemical action producing the time effect, and therefore inclines towards an emission theory of Röntgen rays. E. E. F.

834. *Relation between Constitution and Fluorescence.* **J. T. Hewitt.** (Chem. Soc., Proc. 16. pp. 3–4, Jan. 24, 1900.)—The molecules of substances showing the phenomenon of fluorescence are probably capable of vibrating in two different periodic times; this property would hence be looked for in compounds exhibiting tautomerism, as indeed is the case, almost without exception, with fluorescent colouring matters. Many substances, however, although behaving tautomerically, do not show well-marked fluorescence, possibly owing to the fact that the velocity of change from one tautomeric form to the other in a solution containing the two forms in equilibrium is so small as to allow only a very small proportion of the molecules to absorb energy when in the one configuration and emit it when in the other. When, however, one of the tautomeric forms is symmetrical, the author supposes the molecular structure to be continually undergoing change in a manner analogous to the motion of a pendulum; the symmetrical form first suffers intramolecular displacement to one side, yielding a non-symmetrical form, which then reverts to the symmetrical modification, and this again undergoes displacement, but on the other side of the molecule. The peculiar doubly symmetrical molecular structure necessitated by this theory is possessed by fluorescein and most other fluorescent dye-stuffs; many of the exceptions are probably only apparent, and may be explained when their spectra are more closely examined. T. H. P.

REFERENCES.

835. *Astronomical Objectives.* **H. Harting.** (Zeitschr. Instrumentenk, 19. pp. 274–275, 1899.)—A discussion as to the author's methods of calculation and Leman's modification of the same. [See Abstracts Nos. 1844 (1899) and 482 (1900).]

836. *Electromagnetic Theory of Dispersion.* **P. Drude.** (Ann. d. Physik, 1. 2. pp. 437–440, Feb., 1900.)—This author claims that the theory of dispersion referred to by several authors as that of Hertz is mainly his own, and quotes the letter which Hertz wrote to him on the subject in full. The letter does not contain the formulæ developed by the author, but only a few general suggestions. E. E. F.

HEAT.

837. *Thermal Deformation of Crystallised Normal Sulphates of Potassium, Rubidium, and Cæsium.* **A. E. Tutton.** (Roy. Soc., Phil. Trans. 192. pp. 455–498, 1899.)—In a previous paper (see 1898, Abstract No. 1017) the author described an interference dilatometer, by the use of which, owing to the introduction of compensation for the expansion of the platinum-iridium interference apparatus by means of a disc of aluminium laid on the object, the delicate method of Fizeau is rendered equally sensitive in the determination of the expansion of solid substances, notably crystals, which cannot be obtained in blocks of the relatively large size hitherto required. The method is particularly applicable to the cases of those substances, including the crystals of most artificial chemical salts, whose ground surfaces will not take a polish equal to that of glass. In previous papers the author has described the results of the application of his method to the investigation concerning the relations between the morphological and physical properties of the crystals of isomorphous series of salts on the one hand and their chemical constitution on the other, to the thermal deformation of the salts in question.

In the present memoir the results are given of an investigation of the thermal deformation of the orthorhombic normal sulphates of potassium, rubidium and cæsium. After describing the method of preparation of the crystals (the parallel-faced crystal blocks), the improvements on the cutting and grinding goniometer (which is gone into very fully), the procedure in cutting and grinding the crystal blocks and the mode of conducting the observations, the determinations and computations are explained. The results of the series of observations are given very fully in extensive tables. The comparison of the coefficients of lineal and cubical expansion of the three sulphates is then considered. The principal results and conclusions deduced are as follows :—

1. The most striking result of the investigation is seen by comparing the cubical coefficients of expansion. The coefficients of cubical expansion of the orthorhombic crystals of the three normal sulphates of potassium, rubidium, and cæsium exhibit a progression corresponding to the progression of the atomic weights of the three respective metals. This progression occurs in the case of both the constants a and b in the general expression for the coefficient of cubical expansion $\alpha = a + 2bt$ for any temperature t.

2. The order of progression of the two constants is inverted; a, the coefficient for 0°, diminishes with increasing atomic weight of the metal, while b, half the increment of the coefficient per degree of temperature, increases.

3. The coefficients of cubical expansion of the three salts converge with rise of temperature towards equality, which they reach at about 186°. Beyond this temperature the coefficients of expansion exhibit increasing divergence, the order of progression being inverted, an increase in the atomic weight of the metal being now accompanied by an increase in the coefficient of cubical expansion.

4. The thermal deformation is of the nature of an expansion in all directions in the crystals of all these sulphates.

5. The coefficients of linear expansion for any one direction of the three salts do not exhibit any progression corresponding to that of the atomic weights.

6. The increment of the linear coefficient of expansion for the direction of the vertical axis *c* of each salt is about twice as large as the increments for the other two directions *a* and *b*, for which latter the increments are nearly equal.

7. The amount of expansion along the direction of the crystallographical axis *b* is approximately identical for all three sulphates, indicating that interchange of the metals is without influence on the thermal behaviour along the macro-diagonal axis of the crystals. The crystals of all three salts also expand least in this direction, which is therefore the common minimum axis of the thermal ellipsoid. The maximum thermal axis is identical in all three salts with the optical first median line.

8. At higher temperatures the same relations still obtain for the potassium and cæsium salts, but at 50° the crystals of rubidium sulphate are apparently thermally uniaxial, owing to the great increment of expansion along the axis *c*.

9. In general a close parallelism between the linear thermal expansion and the directional optical behaviour is seen to exist, and the same progressive effect of variation of the atomic weight of the metal affects both, but in the former case it is masked.

As in the case of the alkaline selenates investigated by the author the general principle holds good that the difference in the nature of the elements of the same family group, which is manifested in their regularly varying atomic weights, is also expressed in the similarly regular variation of the character of the crystals of an isomorphous series of salts of which these elements are the interchangeable constituents. J. J. S.

838. *Thermal Expansion of Liquids.* **G. Guglielmo.** (Accad. Lincei Atti, 8. pp. 271–276. and 310–316, 1899.)—The author describes a modification of Dulong and Petit's method of measuring the absolute thermal expansion of liquids, by which the sensitiveness of the method is greatly increased. Instead of two vertical tubes only, kept at different temperatures, a long tube is used which is bent into a kind of spiral of rectangular section. The whole of the vertical portions on one side are kept at the higher temperature, and the whole of the vertical portions on the other side are kept at the lower temperature. The differences of pressure so produced are thus added up, and the displacement of the levels in the open terminal portions is multiplied by the number of turns, without a serious increase in the sources of error.

E. E. F.

839. *Thermal Conductivity of Heat Insulators.* **C. G. Lamb** and **W. G. Wilson.** (Roy. Soc., Proc. 65. pp. 283–288, 1899.)—A method of testing the comparative efficiency of materials used as insulators is described. The method was devised with the object of using lower temperatures and smaller ranges than had been used in previous experiments, to attain a perfectly steady state of heat transference, and allow of greater accuracy and simplicity in the measurements. The substances used were tested in the dry state, and include air, sawdust, charcoal, hair felt, &c. The method used consisted in placing the material under test in the space between two cylindrical copper pots, kept at a definite distance apart by pieces of vulcanised fibre ; the inner pot contained a small motor with a fan attached to its axis ; a tin-plate

cylinder open at the top and with holes at the bottom, was put inside to direct the currents of air over the inner surface of the inside pot. Energy was supplied electrically to a heating coil within; as well as to the motor: this constituted an internal supply of heat, which maintained the temperature within the pot at any decided upper limit. The motor and coil were connected in series, and leads were carried through a small hole in the lid of the pots to measure the current and potential difference, and thus the power expended on internal heating was measured. The outer pot's surface was kept at a uniform and constant temperature by being immersed in a tank through which water flowed from the mains. The resulting temperature differences were measured by means of thermoelectric junctions of copper and iron. The current was passed steadily into the inner pot, driving the motor and fan, until the inner thermoelectric junction arrived at a steady value; this usually occurred in about three hours; when this was the case the supply of energy by the current was just equal to the heat conducted through the insulator and carried off by the water. Knowing the temperature gradient and the number of watts supplied and the dimensions of the system, the specific conductivity of the material can be deduced.

The following results were obtained :—

Material.	Conductivity.
Air (no baffles)	0·000200
Pine sawdust	0·000242
Pine shavings	0·000162
Brown paper (crumpled up)	0·000167
Hair felt (broken up)	0·000145
Hair felt in two sheets ½ in. thick each	0·000106
Dry asbestos	0·000297
Charcoal	0·000150
Sand	0·000740
Rice husks	0·000150
Kapok (a heat insulator)	0·000144
Kapok (loose)	0·000122
Silicate cotton	0·000151

In these experiments the temperature differences varied from about 8° to 28°. Hair felt was the best insulator tested. The insulation in the case of brown paper was practically that of air with subdivided spaces; the improvement thus produced in comparison with air only is noticeable. J. J. S.

840. *Measurement of Low Temperatures.* **A. Ladenburg** and **C. Krügel.** (Ber., 32. pp. 1818–1824, 1899, and 33. pp. 637–638, March 12, 1900.)—In using a thermoelectric couple for measuring low temperatures the authors do not consider that it is sufficient to use a quadratic equation, and have therefore made use of a cubic equation to express the relationship between temperature and voltage. The thermal element was compared with a hydrogen thermometer at three standard temperatures, viz., the boiling-point of liquid air: — 191·25°; of ethylene, — 102·9°; and the sublimation-point of solid carbon dioxide, — 77·5°. From these three fixed points the three constants in the equation were determined, and its accuracy was tested by comparing the readings of the hydrogen thermometer with those of the thermal element at (1) the boiling-point of methane (— 162°), and (2) the melting-point of ether (— 113°); the readings differed by only 0·05° and 0·5° in the two cases.

The boiling- and freezing-points of a number of substances were then determined, and are given in the accompanying table.

Substance.	Boiling-point.	Melting-point.
Oxygen	—182·2° at 745·0 mm.	...
Nitrous oxide	—142·8° at 757·2 mm.	—150·5°
Ammonia	...	— 75·5°
Hydrogen chloride	— 83·1° at 755·4	—111·3°
Hydrogen bromide	— 68·1° at 755·4	— 86·13°
Hydrogen iodide...	— 36·7° at 751·7	— 51·3°
Hydrogen sulphide	— 60·4° at 755·2	— 82·9°
Methane	—162° at 751·0	...
Ethane	— 84·1° at 749·0	—172·1°
Propylene.....	— 48·2° at 749·0	remains liquid at — 190°
Trimethylene	about — 34° at 749·0	—126·6°
Acetylene	— 82·4° (sublimation point)	sublimes
Toluene.....	+110°	— 93·2°
Ethylbenzene	+135 to +136°	— 93·2°
Mesitylene	+164°	— 57·5°
Cymene.....	.....	— 73·5°
Methyl chloride ...	.....	—102·9°
Ethyl bromide.....	.....	—115·8°
Ethyl iodide.....	.....	—110·6 to —113·1°
Methyl alcohol.....	.....	— 93·9°
Ethyl alcohol	.....	—111·8°
Ether.....	.....	—113·1°
Aldehyde	.....	—120·6°
Acetone.....	.....	— 93·9°
Glycol	.....	— 15·6°
Methyl formate ...	+32–33°	—100·4°
Ethyl acetate	.....	— 82·4°
Ethylamine	+19–20°	— 83·8°

Mesitylene and alcohol solidify in liquid air to a transparent amorphous mass, but become crystalline when the temperature is allowed to rise; ether, aldehyde, and acetone crystallise directly. T. M. L.

841. *Co-volume of Fluids.* **D. Berthelot.** (Comptes Rendus, 130. pp. 115–118. Jan. 15, 1900.)—The kinetic theories lead to equations of the form—

$$p + \frac{a}{v^2} = \frac{RT}{v}\left(1 + \frac{b}{v} + \alpha_1 \frac{b^2}{v^2} + \alpha_2 \frac{b^3}{v^3} + \ldots\right)$$

When the pressure is small and the volume great, powers of $\frac{b}{v}$ beyond the first may be neglected. In any case, the above equation represents very faithfully the isothermals obtained by van der Waals. But these deviate from experiment just in those parts where the pressure is smallest. The author proposes to regard the co-volume as a function of the temperature, according to the equation—

$$b_T = b_c\left\{1 + 0{\cdot}3\left(\frac{T}{T_c} - 1\right)\right\}$$

where b_T is the co-volume at temperature T, and b_c the co-volume at the critical temperature. This leads to equations which may safely be applied to liquids. E. E. F.

842. *Internal Pressure of Gases.* **D. Berthelot.** (Comptes Rendus, 130. pp. 69–73, Jan. 8, 1900.)—The author compares the total results of experiment available up to the present with the various formulæ proposed for the characteristic equation of fluids, and arrives at some simple and satisfactory formulæ applicable to the liquid state. The reasoning employed is based upon the law of corresponding states. Since the characteristic equation may contain only three constants special to the body under investigation, the author only considers equations involving three such constants. From these he deduces, by Sarran's method, the elements of the critical point and the reduced equations common to all bodies. The critical isothermals so obtained are compared with the experimental critical isothermal of carbonic acid as a standard. Van der Waal's formula agrees with Amagat's experimental results for higher values of ω, but not for the lower values. The modified form introduced by Clausius agrees for the lower values but not for the higher values. To obtain a complete agreement, the author goes a step further than Clausius, and substitutes for the term $\frac{a}{v^2}$, not $\frac{a}{(v+nb)^2}$ but $\frac{a}{v^2 + 2\,lvb + mb^2}$. The revised formula may be used for liquids by inserting three constants characteristic of the body in question, preferably the critical pressure and temperature and the molecular weight. E. E. F.

843. *Liquefaction of Gaseous Mixtures.* **F. Caubet.** (Comptes Rendus, 130. pp. 167–169, Jan. 22, 1900.)—The author has constructed the limiting lines for ten mixtures of methyl chloride and carbon dioxide, of composition varying between 10 and 90 per cent. The results are given in the form of a figure which shows also the critical line and the lines of evaporation and condensation. Retrograde condensation is shown by all the mixtures, and is particularly well marked for 40 per cent. of methyl chloride. R. A. L.

844. *Heat of Sublimation of Carbonic Acid.* **U. Behn.** (Ann. d. Physik, 1. 2. pp. 270–274, Feb., 1900.)—If the mean specific heat of any solid is known between 18° and — 79° or — 186°, it is easy to determine the heat of sublimation of solid CO_2, or the heat of evaporation of air with its aid. It is only necessary, in the latter case, to introduce the body of known temperature into boiling air. The air will go on evaporating until the body has the temperature of the boiling-point of air, and it only remains to measure the volume of gaseous air. The quantities thus determined by the author with the aid of an aluminium cylinder are—

CO_2, heat of sublimation : 142·4 calories.
Air, heat of evaporation : 50·8 calories.

From these figures, the specific volumes of gaseous CO_2 at — 79° and of gaseous air at — 186° may be found. They are 423 and 358 respectively.
E. E. F.

SOUND.

845. *Reflection of Sound at a Paraboloid.* **H. J. Sharpe.** (Cambridge Phil. Soc., Proc. 10. pp. 101–136, 1899.)—A sound-reflecting paraboloid of revolution is placed with its axis corresponding with that of x, and sound vibrations are going on within the paraboloid and are reflected by the surface. The source of sound may be at an infinite distance or at the focus of the reflector or elsewhere within it. In the present paper the motion is assumed to be symmetrical about the axis. The author does not here discuss the case which he says is the most interesting, viz., that in which the source is at the focus, but the next most interesting case is treated, viz., that in which we have a line of sources extending from the vertex for a finite distance along the axis. The treatment is subdivided according to the values of the constant A in the equations $V\frac{d^2V}{dv^2}+\frac{dV}{dv}+(p^2v\pm A)V=0$, the most important cases being when A is large. S. H. B.

846. *Electric Transmission of Sound.* **Dussaud.** (Comptes Rendus, 129. pp. 880–881, 1899.)—The electric transmission of sound (see 1899, Abstract No. 560) is the more efficient the greater the number of the microphone membranes enclosed in the resonator box, and the efficiency is also increased by letting the air act upon both faces of the membranes. At the receiving station the electromagnet should have several faces, each actuating a diaphragm, and the sound should be collected from both faces of the diaphragms. The intensity of the transmitted sound is then sufficient to work a phonograph. It has been found possible to thus record telephonic communications over several miles of wire, and also to take down a speech delivered in a remote part of a building and reproduce it from the phonograph in the lecture theatre, practically without loss of intensity. E. E. F.

847. *Sensitive Flame Tests on a Telephone Transmitter.* **Rayleigh.** (Roy. Instit., Proc. 15. pp. 786-789, 1899.)—Lord Rayleigh describes a special sensitive flame made by a pin-hole (0·03″) jet, over which is a chamber one side of which is fitted with a diaphragm of paper or a transmitter diaphragm. Experiments with an induction balance and an alternating current are given which can be shown by the flame in a lecture demonstration. M. O'G.

ELECTRICITY.

848. *Electromagnetic Theory.* **A. Scheye.** (Zeitschr. Phys. Chem. 32. pp. 145–149, Feb. 6, 1900.)—The author replies to Wedell-Wedellsborg (see 1900, Abstract No. 96), who gives two grounds for doubting the existence of the electric field due to a galvanic current: firstly, that it does not agree with experiment; secondly, that it leads to inconsistent results. The author agrees with the first objection so far as to admit that further decisive experiments are required. The second objection he combats in the present paper, maintaining that as the six equations expressing Maxwell's theory are consistent with each other, we cannot, if we confine our assumptions to them, arrive at inconsistent results. This he illustrates by the example of a fixed circuit and the introduction of another circuit into its field; and by discussion of the galvanic circuit of two metals and an electrolyte. This he says leads to Maxwell's expression for the energy of the field.

$$\int \frac{K}{4\pi} \left\{ \left(\frac{d\phi}{dx}\right)^2 + \left(\frac{d\phi}{dy}\right)^2 + \left(\frac{d\phi}{dz}\right)^2 \right\} d\tau.$$

where ϕ is the potential. He agrees with Wedell-Wedellsborg that strictly in electric induction we cannot regard resistance as constant. And we may assume, he says, that an electric potential exists even in a non-stationary state, depending in the same way on the currents for the time being as in the stationary state. But this assumption, he points out, involves difficulties.

S. H. B.

849. *Hydro-dynamical Hypothesis of Electromagnetic Actions.* **G. F. FitzGerald.** (Roy. Dublin Soc., Proc. 9. pp. 50–54, 1899.)—After referring to Kelvin's investigation as to a possible transference of a laminar wave disturbance through a turbulent liquid (Phil. Mag. v. vol. 24. p. 342, 1877), and his subsequent calculation of a stable, steady motion for a hollow vortex surrounded by a tore round which the liquid is circulating (Roy. Irish Acad. Proc. iii. vol. 1. p. 340, 1889), the author proceeds to explain his own hypothesis, according to which the ether is a turbulent liquid, the Faraday tubes being represented by vortex spirals. A vortex filament, the author points out, can have a spiral wave superposed on it, and the irrotational motion in the neighbourhood of such a spiral will be essentially the same as the distribution of magnetic force near a similar spiral wire conveying an electric current. The author next considers the transference of spirality from one vortex to another, and arrives at equations which are identical with the fundamental equations of wave propagation in the ether. An electric charge is represented by a singular point on a vortex spiral, at which the flow of fluid is away from the point on both sides, the spirality on one side being right-handed, and that on the other left-handed.

A. H.

850. *Electromagnetic Rotations.* **Raveau.** (Comptes Rendus, 130. pp 31–32, Jan. 2, 1900.)—This is a reply to Lecher's criticism of König's experiment (see 1900, Abstract No. 94). Though it is immaterial to the final result whether the point of application of the electromagnetic forces is absolutely final or not, the lack of definiteness in fixing it leads to ambiguities in the point of view adopted. To explain Faraday's electromagnetic rotation, in

which one of the poles of a vertical magnet describes a circle about a portion of a vertical straight conductor carrying a current, it is maintained, from the point of view of Biot and Savart, that the motion is determined by the action of the current upon the neighbouring pole. According to Ampère's view, on the other hand, the force exercised by the part of the circuit meets the vertical wire and cannot produce any rotation about it. These two views are not incompatible, as their application depends upon different conditions. Lecher's experiment, in which no rotation is produced, differs from Faraday's arrangement by the substitution of two joints for the movable contacts.

E. E. F.

851. *Potentials and Capacities where the Dielectrics are Heterogeneous or Conducting.* **A. A. Petrovsky.** (Comptes Rendus, 130. pp. 112–115, Jan. 15, and 164–166, Jan. 22, 1900.)—Starting with Maxwell's form of Laplace's equation the author obtains the following results for capacities :—

(1) *Plane condenser* with plates of area S, and dielectric of n layers, d_i and K_i denoting the thickness and dielectric constant respectively of the layer whose number is i:

$$\text{Capacity} = S \div 4\pi \sum_{i=1}^{i=n} \frac{d_i}{K_i}$$

(2) *Spherical condenser* with n concentric spherical layers of dielectric :

$$\text{Capacity} = 1 \div \sum_{i=1}^{i=n} \frac{1}{K_i}\left(\frac{1}{r_{i-1}} - \frac{1}{r_i}\right)$$

(3) *Cylindrical condenser* with n coaxial cylindrical layers of dielectric :

$$\text{Capacity} = \text{Length} \div 2 \sum_{i=1}^{i=n} \frac{1}{K_i} \log \frac{\rho_i}{\rho_{i-1}}$$

The potential is next obtained round a sphere immersed in a concentric sphere of conducting dielectric. In conclusion follows a discussion of the experimental determination by alternating currents of the capacity of a condenser with heterogeneous dielectrics. E. H. B.

852. *Atmospheric Electricity.* **G. Schwalbe.** (Ann. d. Physik, 1. 2. pp. 294–298, Feb., 1900.)—As against Pellat's obervation of an apparent loss of charge due to evaporation (see 1899, Abstracts Nos. 562 and 1375), the author has repeated his experiments, which show that a metallic vessel filled with hot water does not lose its charge. In this case he employed potentials as high as those employed by Pellat, and made separate observations for positive and negative charges. The results obtained were the same as before, and the author is convinced that no electric charge is conveyed by evaporation. Hence Enner's theory of atmospheric electricity is inadequate. E. E. F.

853. *Diselectrification Produced by Magnetism.* **C. E. S. Phillips.** (Roy. Soc., Proc. 65. p. 320, 1899.)—Under certain conditions an electrified body rapidly loses its charge when in the neighbourhood of a magnetic field. The phenomenon is only exhibited at pressures lower than 0·2 mm. of mercury. A glass tube has two tinfoil coatings, one inside and one outside. The former is electrified positively, and the "free" charge on it indicated by an electroscope : this charge induces a "bound" charge on the outside coating. On actuating an electromagnet whose poles protrude through the ends of the glass tubes the leaves of the electroscope suddenly collapse. No such effect is observed when the inner coating is charged negatively. D. E. J.

854. *Electrographs.* **E. Gates.** (Electricity, N.Y. 17. pp. 359–360, 1899. From the Photographic Times.)—Illustrations are given of electrographs formed by the passage of an electric discharge through and over a photographic plate. In order to obtain these effects a camera is unnecessary. It is sufficient to enclose the plates in a light-proof envelope. The plates when developed exhibit a foliated appearance of great delicacy, similar to that of certain varieties of seaweed. R. A.

855. *Point Discharges.* **H. Sieveking.** (Ann. d. Physik, 1. 2. pp. 299–311, Feb., 1900.)—Discharge of statical electricity from a point always occurs at a lower potential in the case of negative charges than it does in the case of positive charges. Under equal conditions the quantity of negative electricity discharged is always greater than the quantity of positive electricity. The quantity discharged, either upon a disc or upon the inner surface of a conducting sphere, may be represented by the formula $E = a\ (V - b)$, when b is the minimum discharge potential. The formula applies to potentials lying between the minimum potential and 5,000 volts. For higher potentials Warburg's formula $E = cv(V - M)$ is more in agreement with experiment. The minimum potential is nearly constant at greater distances, but increases rapidly at smaller distances. The gases investigated may be arranged in a series according to their power of furthering negative discharges. Oxygen is at the head of this series, and carbonic acid at the end. E. E. F.

856. *Discharges in an Electrostatic Field.* **J. Stark.** (Ann. d. Physik, 1. 2. pp. 430-436, Feb., 1900.)—Various effects in the way of stopping or facilitating the discharge of a battery through a rarefied gas may be brought about by bringing conductors variously charged into the neighbourhood of the vacuum tube. Whenever such conductors have the effect of increasing the difference of potential between the electrodes, the discharge is facilitated; otherwise it is rendered more difficult, and usually made intermittent. Such intermittent discharges are capable of setting up vibrations in the kathode, which can be heard on bringing the ear close up to the tube, or wrapping a strip of tinfoil loosely round the tube in the neighbourhood of the kathode. When the electrodes consist of flexible wires or carbon filaments, the kathode often exhibits strong oscillations, whereas the anode remains steady. The difference between the anode and the kathode is probably due to the greater drop of potential at the kathode, which makes it more sensitive to variations of the field between itself and the walls. E. E. F.

857. *Duration of Electric Spark.* **H. Abraham** and **J. Lemoine.** (Comptes Rendus, 130. pp. 245–248, Jan. 29, 1900.)—The method employed to test for a retardation in the disappearance of the Kerr phenomenon (see 1899, Abstract No. 1859) may also be used for determining the duration of the electric spark and studying its initial stages. It is found that the total quantities of light emitted by the spark is much less than 40 times that which is emitted during the time required for the cessation of the Kerr effect. That time, as we know, does not exceed 1/100th of a micro-second. If the spark has a uniform intensity over its whole duration, we may suppose that its duration is much less than 0·4 micro-second. Another conclusion arrived at is that in about 1/400th of a micro-second the spark reaches a considerable brightness, not far from its maximum brightness. The disappearance of the Kerr phenomenon as studied with the author's apparatus consists of the three elements, and involves the time during which the Kerr condenser

discharges itself, the time during which the carbon bisulphide preserves its bi-refracting power after the withdrawal of the field, and the time required for the establishment of the spark. Each of these processes, taken separately, has a duration not exceeding a hundred-millionth of a second. E. E. F.

858. *Break-up of a High-Potential Current into Disruptive Discharges.* **H. Abraham.** (Soc. franç. Phys., Séances, 2. pp. 70–77, 1899.)—A high-voltage transformer, actuated by an alternating current; the terminals of a condenser connected with the poles of the transformer, and also with the two electrodes of a deflagrator. On working in the first place without blowing the air away in the deflagrator, a sufficient current will produce a true flame in the deflagrator, the brightness of which follows the alternations of the current, the flame being almost extinguished at each alternation. Like the electric arc, this flame has one pole brighter than the other. With a flame of 2 cm. length and a current of 0·0485 amperes the electromotive force at the poles of the deflagrator is 2,550 volts, showing a resistance of 53,000 ohms; but with the same length of flame under a current of 0·020 amperes the cross-section of the flame is reduced and the voltage becomes 3,400 volts, showing a resistance of 170,000 ohms. The transformer must be able to set up these differences of potential at each alternation as well as to feed the alternating current through the flame. If the current be progressively reduced the requisite differences of potential go on increasing; so that at a given moment the *régime* of flame is transformed into one of disruptive discharges, each discharge lighting up a flame which lasts until the end of the half-period if the actuating current be still sufficiently high for this. There is, however, a continuous gradation between the condition of flame and that of disruptive discharges, for each discharge modifies the air through which it passes and renders it more conductive, so that successive discharges are more and more flame-like. It is difficult to show this by adjusting the actuating current, but it can be readily shown by blowing away the air from between the plates by progressively strengthening currents of air or carbonic acid. If the current of air be very strong the *régime* of disruptive discharges becomes stable and regular, the flow of sparks following the alternations of the actuating current quantitatively according to the sine law. With carbonic acid at a pressure of 3 kg. per sq. cm. more than 100,000 sparks per second were obtained; with air at a pressure of 2 metres of water about 10,000 per second. The phenomenon has a wide range of stability. (See also 1899, Abstract No. 1495.) A. D.

859. *Lichtenberg Figures inside Röntgen Tubes.* **E. Riecke.** (Ann. d. Physik, 1. 2. pp. 414–419, Feb., 1900.)—It is not necessary to employ a mixture of red lead and sulphur in order to bring out Lichtenberg figures opposite the kathode. On close examination of the fluorescent patch it is seen that it branches out into club-shaped projections, dark on a light ground, evidently owing to local negative charges which repel the kathode particles and diminish the fluorescence. Branching structures are also produced, chiefly in a zone adjoining the narrow fluorescent band in the plane of the kathode itself, but also round the fluorescent patch opposite when the tube is "hard." These structures mark lines along which the negative charge, accumulated in the fluorescent patch, travels outward into the positive regions. The multiplicity of the branches is probably due to the fact that the patch has a wavy contour which keeps rapidly fluctuating. E. E. F.

860. *Hall Effect.* **G. Moreau.** (Comptes Rendus, 130. pp. 122–124, Jan. 15, 1900.)—The thermo-magnetic effect discovered by Nernst and Ettinghausen in 1886 may be derived from the Hall effect with the aid of the Thomson effect. The author formulates the former by the equation—

$$e = \frac{K}{\omega} \frac{HJ}{\epsilon}$$

where e is the E.M.F. developed in a thin metallic plate of the thickness ϵ by a flux of heat J and a magnetic field H at right angles to the flux and the current; ω is the conductivity of the metal and K a constant. The Hall effect is similarly represented by—

$$E = c \frac{H}{\epsilon} I$$

where I is the current strength.

If two neighbouring sections of the plate are separated by a distance Δx, and are traversed by a flux of heat, producing a difference of temperature Δt between them, a difference of potential ΔV is produced in accordance with the Thomson effect, and we have—

$$\Delta V = \sigma \Delta t$$

where σ is the "specific heat of electricity" in the plate. The E.M.F., $\Delta V/\Delta x$ per unit of length gives rise under the influence of a magnetic field to a transverse E.M.F. in accordance with the Hall effect. The equation for the Hall effect gives—

$$E = \frac{c}{\rho} H a W$$

where W is the E.M.F. of the primary current, I per unit length, and ρ the resistivity of the plate. Putting $W = \Delta V/\Delta x$ we have for the thermo-magnetic effect—

$$\epsilon = \frac{c\sigma}{\rho} H a \frac{\Delta t}{\Delta x}$$

or, if—

$$K = \frac{c\sigma}{\rho},$$

$$e = KHa \frac{\Delta t}{\Delta x}$$

which is the formula experimentally established by Nernst for his new thermo-magnetic effect.

The calculated and observed results agree well except in the cases of nickel and cobalt. In nickel the calculated effect is only one-third of the observed effect, while in cobalt the value is nearly the same, but the actual sign is positive, while the theoretical sign is negative. No close agreement can be expected unless the mode of preparation of the specimens is rigidly the same. E. E. F.

861. *Electrically Heated Conductors.* **H. Diesselhorst.** (Ann. d. Physik, 1. 2. pp. 312–325, Feb., 1900.)—While limiting the discussion to the simpler problem of an electrically heated conductor as stated by Kohlrausch, admitting, however, any variation of the conductivity with the temperature, the author proves that only a single solution satisfies the differential equations and terminal conditions. He also sketches a method whereby the general integration of the equations can be reduced to a known problem of greater simplicity, involving Laplace's equation. As regards the introduction of the

Thomson effect, he proves in a concrete case that it involves a difference of temperature lying somewhere between 0·05° and 0·5°, whilst the Joulean heating amounts to 6° or 7°. (See also 1900, Abstract No. 137.) E. E. F.

862. *Hysteresis of Resistance.* **H. Chevallier.** (Comptes Rendus, 130. pp. 120–122, Jan. 15, 1900.)—When a wire is subjected to periodic variations of temperature its electric resistance varies in a very irregular manner. If R is its resistance at a temperature T_0, and it is heated to a temperature T_1, and subsequently cooled down to T_0, its resistance will finally be different from R. The difference is due to some allotropic transformation undergone by the metal, which is subject to hysteresis. There is not only a change of temperature, but also a complication introduced by the alternate annealing and tempering of the wire. The author's experiments dealt with a silver platinum alloy which resists oxidation. He made the temperature oscillate a large number of times between T_0 and T_1, and found that the resistance at T_0 acquired values differing from each other by a less and less amount as the alternations proceeded, without the difference, however, disappearing entirely. Several series of 70 oscillations each between 150° and 15° gave final values for 15° amounting to 1·01509, 1·01500, 1·01493, 1·01490, 1·01488, and 1·01487 respectively. The last limiting value is practically final for 15°, but it is disturbed by heating the wire to a temperature above 150°. By repeating the oscillations and introducing the disturbance systematically the author obtains a limit of the limits which completely fixes the final temperature for the range and disturbance specified. E. E. F.

863. *Fault-Testing in Cables.* **J. Garraud.** (Écl. Électr. 22. pp. 139–140, Jan. 27, 1900; Annales télégraphiques, 25. pp. 289–295.)—The author describes methods of finding earth faults of insulation in lead-covered cables by the application of an interrupted current to the circuit and the movement of a bobbin along the external sheath, the bobbin being in circuit with a telephone. As the bobbin moves towards or past the fault, so the sound in the telephone is maintained or ceases altogether. With the telephone, therefore, as the detector the position of the fault may be exactly estimated in a single conductor cable. This is referred to as the method of E. Gerard, used fifteen years ago. But M. Barbarat has developed the idea for finding a fault in a bundle of lead-covered wires to which so simple a process would not be practicable. He ascertains by ordinary means the section of the line in which the fault is situated and its approximate situation, detaches from the bundle the portion of the defective cable comprised between the fault and the shortest end, suspends it by insulating tape or cords, and applying the interrupted current to the far end slides the bobbin along the sheaths until the sound ceases, and thus ascertains the position of the fault.

There is still a further method, according to Garraud, by which such a test may be applied in cases where one end of the cable cannot be separated out—as, for instance, where a wire is laid up helically with others within a lead sheath. If the bobbin be moved along the latter from the point of application of the battery towards the fault the sound in the telephone rises and falls in regular measure owing to the helical position of the conductor up to the position of the fault, but when that is passed the sound diminishes continuously, for the current does not now follow the conductor, and the rhythm has disappeared. The fault is localised where this change is observed. E. O. W.

864. *Addenbrooke Electrometer.* (Elect. Engin. 25. pp. 150–151, Feb. 2, 1900.)—This instrument differs from the ordinary type of quadrant electrometer chiefly in structural details, and cannot be described conveniently in an abstract. A full description with drawings is given in the article. There are two sets of quadrant plates, and their distance apart is adjustable. With the electrometer coupled up idiostatically, and the plates $\frac{1}{5}$ inch apart, an E.M.F. of 1 volt produces a deflection of from 3 to 5 mm. on a scale at 2 m. distance. It is stated, however, that Addenbrooke has obtained a deflection of 80 mm. with the same E.M.F. G. H. B.

865. *Combined Ammeter and Voltmeter.* **M. Aliamet.** (Électricien, 18. pp. 425–426, 1899.)—This instrument comprises an ammeter and a voltmeter of the Weston type mounted in one case, the pointers moving over separate scales on the same dial. The instrument is designed for use on motor-cars driven by accumulators, the ammeter being for this purpose designed to read, *e.g.*, up to 15 amperes in one direction for charging, and up to 100 amperes in the other direction for discharging. C. K. F.

866. *Measuring Instruments for Alternate Currents.* **M. Aliamet.** (Électricien, 19. pp. 1–5, Jan. 6, 1900.)—The instruments are based on the following principle : A metal disc revolves between the poles of an electromagnet ; the poles are partially screened from the disc by the interposition of copper plates ; an alternating current through the electromagnet then produces two fields through the disc, one directly and the other through the screens. These are displaced in regard to phase and position, and consequently produce a rotating field, which gives rise to a turning movement in the disc.

In the ammeters and voltmeters the current passes through the electromagnet, and the pointer is attached to the disc, which is controlled by a watch-spring ; its oscillations are damped by a permanent magnet. In the wattmeter the main current passes through one electromagnet, and the shunt current through two others in series, an inductive coil being inserted in their circuit to produce a difference of phase of approximately 90°.

For high-tension currents the instruments receive the secondary current of a transformer with its primary in the high-tension circuit. For very large currents the same arrangement is adopted in the case of the ammeters and wattmeters, the primary of the transformer being a flat plate of copper which is bolted in a gap in the main conductors. G. H. B.

867. *Power Factor Measurements.* **A. J. Bowie, Jr.** (Elect. World and Engineer, 34. pp. 898–901, 1899.)—This paper considers the power factor of alternating current circuits when the current and potential difference cannot be represented by simple sine curves. The power factor is defined to be the ratio of the true watts to the apparent watts, and the phase difference to be that angle whose cosine is equal to the power factor.

Two special cases are considered, in which (1) the potential difference and the current are respectively given by—

$$e = 10 \sin \alpha + \sin 3\alpha$$
$$i = 10 \sin \alpha + 2 \sin 3\alpha + \sin 5\alpha$$

and (2) they are respectively—

$$e = 10 \sin \alpha - \sin 3\alpha + \sin 5\alpha$$
$$i = 10 \sin \alpha - 2 \sin 3\alpha + 3 \sin 5\alpha$$
$$- 2 \cos \alpha + \cos 3\alpha + \cos 5\alpha$$

Different values of phase difference being assumed, tables are given showing the actual calculated values of the power factor, and the corresponding values on the assumption that the functions may be represented by sine curves. For example, when the phase difference is zero the actual power factor is 0·991 in Case 1, and 0·958 in Case 2. W. G. R.

868. *Magnetisation of Brickwork by Lightning.* **P. Gamba.** (Accad. Lincei Atti, 8. pp. 316–320, 1899.)—The author describes several well-marked instances of the magnetisation of masonry struck by lightning. In a house near Viterbo several magnetised portions of a wall were discovered, one of which marked a point passed through by the discharge. The author believes the magnetisation to be quite independent of terrestrial magnetism, and solely due to the direction of the discharge. He believes with Folgheraiter that most of the fragmentary rocks of the Roman Campagna which exhibit magnetic polarity acquired it through lightning discharges. E. E. F.

869. *Molecular Susceptibility of Paramagnetic Salts of the Rare Earths and of the Iron Group.* **O. Liebknecht,** with **H. du Bois** and **A. P. Wills.** (Ber., 32. pp. 3344–3348, Dec. 11, 1899, and 33. pp. 443–445, Feb. 12, 1900.)—The method used for determining the magnetic susceptibility of a paramagnetic salt consists in neutralising the diamagnetism of the water by the addition of the salt. When this has been done exactly, a meniscus of the solution in a capillary tube does not move either forwards or backwards when placed in a magnetic field.

In the case of the chlorides of the rare earths the molecular susceptibility i_m increases steadily with the atomic weight from yttrium ($i_m = 0{\cdot}00021$) through cerium, praseodymium, neodymium, samarium and gadolinium to erbium ($i_m = 0{\cdot}03668$), and then falls abruptly to ytterbium ($i_m = 0{\cdot}00711$).

A similar maximum occurs in the iron group, in which the magnetic susceptibility of a large number of salts has been determined. The mean values for the molecular susceptibility are as follows :—

	Atomic Weight.	i_m.
Chromium.....	52·1	0·00615
Manganese	55·0	0·01520
Ferrous iron.....	56·0	0·01274
Cobalt	59·0	0·01039
Nickel	58·7	0·00441
Copper	63·6	0·00162

For ferric iron the mean values are $i_m = 0{\cdot}01352$ for the nitrate and chloride, but $i_m = 0{\cdot}01510$ for the bromide, sulphate, and oxalate, a difference of about 12 per cent. It will also be noticed that iron resembles cobalt more than nickel, although the atomic weight of the latter is supposed to be the smaller. T. M. L.

REFERENCES.

870. *Oscillations round a Theoretical Hertzian Oscillator.* **K. Pearson** and **A. Lee.** (Roy. Soc., Phil. Trans. 193. pp. 159–188, 1899.)—The full text of the paper, of which a preliminary abstract has already appeared. (See 1899, Abstract No. 1169.) The subject is treated from the mathematical point of view.

871. *Magnetism.* **C. Maurain.** (Écl. Électr. 22. pp. 201–206, Feb. 10, 1900.) —An article dealing mainly with the bibliography of the subject in its various aspects.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

872. *Solubilities of Argon and Helium in Water.* **T. Estreicher.** (Zeitschr. Phys. Chem. 31. pp. 176–187, 1899.)—The author, using a greatly improved form of the apparatus described by Ostwald in his book on physico-chemical measurements, has made a very careful determination of the solubility-coefficients of argon and helium for every fifth degree between 0° C. and 50° C. Helium is found to show a *minimum* at about 25°. The author points out that the solubility curve of a gas must show a minimum at some temperature below the critical point of the system, since at that point the solubility becomes infinite. He compares the case of helium with that of hydrogen, which appears to possess a minimum solubility either at 60° C. or somewhere between that and 100° C. A minimum point on the argon curve was not reached. Argon probably possesses a minimum near that of oxygen. From the diagram given by the author, it is seen that the solubility curves for nitrogen and helium intersect at 30° C. To give an idea of the solubilities, the results obtained at 15° C. may be quoted.

Gas.	Vol., measured at 0° and 760 mm., dissolved by one volume of water at 15° C. and 760 mm.
Argon	·04099
Helium	·01396

F. G. D.

873. *Colloid Solutions.* **G. Bredig** and **A. Coehn.** (Zeitschr. Phys. Chem. 32. pp. 129–132, Feb. 6, 1900.)—A criticism of the work of Stoeckl, Vanino, and Stark (see 1899, Abstracts Nos. 1740 and 1741), many of whose results are said to have been anticipated by other observers whom they fail to notice. Experiments by Bredig seem to disprove Stark's theory as to the connection of air-bubbles with the precipitation of colloid metallic solutions.

N. L.

874. *Colloidal Cadmium.* **G. Bredig.** (Zeitschr. Phys. Chem. 32. pp. 127–128, Feb. 6, 1900.)—Except under special conditions the preparation by chemical means of colloid solutions of metals more electropositive than hydrogen is impracticable, since water would necessarily be directly decomposed by the reducing agent employed. If, however, an electric arc is formed under water between cadmium electrodes, using a current of 5–10 amperes at 30–40 volts, a dark brown solution of the metal is obtained, which gradually oxydises on exposure to air, and is coagulated by the addition of electrolytes. A solution of zinc was also obtained in the same way, but this is very unstable.

N. L.

875. *Relations between the Atomic Weights and Physical Properties of Elements.* **T. Bayley.** (Chem. News, 80. p. 282, 1899.)—It is pointed out that the product of the absolute melting-point and the coefficient of linear expansion is approximately constant for many elements, and equal to about 0·02. In the case of magnesium, silver, sulphur, sodium, and potassium, higher values are found—0·024 to 0·028. From this relation it follows that the atomic expansion, measured from absolute zero to the melting-point,

varies directly as the atomic volume. It is also shown that among elements of similar character simple relations exist between the values found for the ratio of the atomic heat to the square of the atomic weight. Thus the value of this ratio for potassium is very nearly one-third of the value for sodium, and the value for zinc is half that for copper. N. L.

876. *New Spectrum Lines of Argon.* **R. Nasini, F. Anderlini,** and **R. Salvadori.** (Accad. Lincei Atti, 8. pp. 269–271, 1899.)—The author announces the discovery of some new lines in the infra-red spectrum of argon. They are six in number, and all rather faint. Their wave-lengths are: 798·0; 803·0; 814·0; 832·0; 845·0; and 857·5. The material from which the argon was obtained was taken from a fumarole of Vesuvius. The spectrum shows all the usual lines of argon, though their intensities are distributed in a somewhat different manner. E. E. F.

877. *Hydrolysis of Chloride Solutions on Standing or by Light.* **F. Kohlrausch.** (Deutsch. Phys. Gesell., Verh. 1. pp. 259–264, 1899.)—The author shows that the gradual hydrolysis which takes place in aqueous solutions of platinum tetrachloride, as evidenced by a decrease of the electrical conductivity, is caused mainly by the action of light. Sunlight accelerates the hydrolysis to a much greater extent than diffused daylight, whilst light passed through a yellow glass exerts very little influence, this being also the case with incandescent gas light. The action on strong solutions is relatively slower than with weak. Hydrogen platinichloride shows similar behaviour, the hydrolysis of dilute solutions being considerably accelerated by the action of light; strong solutions, however, show no change in conductivity, either spontaneous or caused by light. Gold chloride is not sensitive to light, but when a dilute solution is left in the resistance cell a change occurs in which the platinum-black of the electrodes takes part. The author's observations on stannic chloride have been partially anticipated by Foster (see 1899, Abstract No. 1938), with whose results they agree; light produces no hydrolysis in this case. T. H. P.

878. *Physico-Chemical Studies of Tin.* **E. Cohen** and **C. van Eijk.** (Zeitschr. Phys. Chem. 30. pp. 601–622, 1899.)—The crumbling of ordinary white tin into powdery grey tin was observed in 1851 by O. L. Erdmann in the case of some old organ-pipes containing 3·7 per cent. of lead, and again in 1869 by Fritzsche in the case of some blocks of pure tin which had been exposed to an intense cold during the preceding winter. Fritzsche showed that the change from grey to white tin was reversible, and could be made to proceed in either direction by heating or cooling. The grey tin has a much lower density than white tin, and when immersed in dilute potash, hydrochloric acid or sulphuric acid appears electronegative towards it.

By using a dilatometer the authors were able to locate the transition-point from grey tin to white tin, since the petroleum in the capillary began to sink when the temperature had been slowly raised to 30°. The position of the transition-point was determined exactly from the electromotive force of an element—grey tin | 10 per cent. solution of pink salt | white tin—which became zero at 20°. It was then found that the conversion of white tin into grey tin, which cannot readily be brought about even by cooling to −83°, can be easily effected by cooling to −15° if a few drops of the pink-salt solution are added to the tin-powder; the change from grey to white at temperatures only a few degrees above the transition-point also takes place quite readily in

presence of a few drops of pink-salt. The determination of the transition-point shows that, except during a few warm days in summer, the whole of the world's tin supply is in a metastable condition, and tends slowly to crumble away to grey tin. Determinations of the velocity of change showed that the conversion of white tin to grey tin takes place most rapidly at about — 48° C.; grey tin can, however, be prepared in large quantities by mixing a large mass of tin-filings with a little grey tin, adding pink-salt solution and keeping at — 5° during eight days. T. M. L.

879. *New Type of Transition Element.* **E. Cohen.** (Zeitschr. Phys. Chem. 30. pp. 623–627, 1899; read before the Königl. Akad. der Wissenschaften zu Amsterdam. Sept. 30, 1899.)—The new type of transition-element is that made use of in the work described in the preceding Abstract, and consists of the combination: Metal M (stable α-modification) | dilute solution of a salt of the metal M | metal M (metastable β-modification).

T. M. L.

880. *Hydrolysis of Salt Solutions.* **L. Bruner.** (Zeitschr. Phys. Chem. 32. pp. 133–136, Feb. 6, 1900.)—The author gives the results of determinations of the hydrolytic dissociation of solutions of varying strengths of twenty-three chlorides, ten nitrates, and three sulphates, the optical sugar-inversion method of measurement being made use of. The following are the conclusions drawn: (1) The chlorides of the tetravalent metals are the most highly dissociated salts, stannic chloride, for example, being completely dissociated at the dilution $v = 8$. (2) After these come the salts of iron, aluminium, uranium, and beryllium, which mostly show considerable dissociation. (3) For other salt solutions the amount of dissociation is always much less than 1 per cent. No hydrolysis can be detected in solutions of ammonium, potassium, lithium, manganous, cobaltous, cerous, or erbium chloride, nor in silver, manganous or cobalt nitrate. For the chlorides of the alkaline earth metals, the percentages of dissociated salt lie between 0·02 and 0·07 per cent., and are hence too small to be reliable. (4) In the case of uranium, aluminium, and beryllium salts, the chlorides suffer the most and the sulphates the least hydrolysis, the nitrates being intermediate. The results of the author's work, which was originally published in Polish by the Warsaw Society for Promoting Trade and Industry (Wszechswiat, 1893. 23. 365), are in complete accord with those of Ley (Zeitschr. Phys. Chem. 30. 2. 218, 1899). T. H. P.

881. *Real and Apparent Freezing-point and Freezing-point Methods.* **M. Wildermann.** (Zeitschr. Phys. Chem. 30. pp. 577–585, 1899.)—The author gives a *résumé* of the modern theory of freezing-point determinations, which was founded by Nernst and Abegg, and has since been extended and worked out by himself. Having sketched the theory and given the various formulæ, the author proceeds to explain how these formulæ may be employed to calculate the error of any particular method. The object aimed at in freezing-point measurements is to bring the observed temperature of equilibrium, *i.e.*, the *apparent* freezing-point, as nearly as possible into coincidence with the *convergence-temperature*, *i.e.*, the temperature of radiation-equilibrium with the surroundings. In practice, exact coincidence cannot be attained, and so the author calculates what error is produced by a difference between these temperatures of 0·1° C. By "error" is understood here the difference between the observed temperature of equilibrium and the true freezing-point. He finds for his own method an error of

0.00002° C., and for two other methods errors of 0·006°–0·012° and 0·004°. His conclusion is that for work with very dilute solutions, correct thermometry in the ordinary sense is not sufficient. Everything depends on the correct adjustment of the factors which determine the observed temperature-equilibrium. F. G. D.

882. *Carbon-consuming Batteries and their Possibilities.* **W. R. Cooper.** (Inst. Junior Engineers, Trans. 9. pp. 97–120, 1898–99.)—The author compares the efficiency of a steam-generating plant with a battery, and finds about 12 per cent. in the former and 73 per cent. in the latter case. It is shown that in everyday working the efficiency of the steam-plant will probably be nearer 6 per cent., owing to practical difficulties. There is thus seen to be a great opening for a battery which could transform the chemical energy of the system, carbon + oxygen, into electrical energy. The author then considers the theoretical conditions which a voltaic cell must fulfil, and emphasises the fact that for voltaic action the products of the chemical reaction must appear at separate points. From a consideration of the nature of carbon and its compounds, it is shown that the chief difficulties in constructing a carbon-consuming battery are : (1) Insoluble nature of carbon ; (2) Scarcity of electrolytic carbon compounds ; (3) Inability of carbon to act as an ion. Having shown that the Grove gas cell is commercially useless owing to the slow rate of absorption of the gases by the electrodes, the author goes on to consider the cells proposed by Borchers, Reed, Coehn, Jacques, and Blumenberg, and shows that none of these cells are really true voltaic combinations for transforming the chemical energy of the system carbon + oxygen (or carbon monoxide + oxygen) into electrical energy. They all fail to fulfil the fundamental conditions. F. G. D.

883. *Antimony Trichloride in Cryoscopy.* **S. Tolloczko.** (Zeitschr. Phys. Chem. 30. pp. 705–710, 1899 ; read before the Kaiserl. Akad. der Wissenschaften in Krakau, Nov. 6, 1899.)—In order to test the validity of Brühl's views concerning the causes of the dissociating power of solvents (1899, Abstract No. 861), the author has examined the cryoscopic behaviour of solutions of several organic and inorganic compounds in antimony trichloride. As the heat of fusion of this solvent is unknown, the mean experimental number, 184, is taken for the molecular depression of the freezing-point. Xylene, anthracene, diphenylmethane, acetophenone, and benzophenone show normal molecular weights ; whilst, with potassium chloride and bromide, dissociation occurs to an extent which diminishes as the concentration increases. Antimony chloride, then, possesses dissociating power, as Brühl's theory would indicate.

For determining the molecular weight of organic substances this solvent is very convenient, as it has a very high molecular depression, and hence admits of the use of dilute solutions. T. H. P.

884. *Freezing-points of Solutions.* **E. H. Loomis.** (Phys. Rev. 9. pp. 257–287, 1899.)—The author shows that his cryoscopic method is exact. An error was discovered which was due to the fact that the thermometer when not in use was kept wholly packed in ice. Only the lower part of the thermometer should be so treated, the upper part being kept at the temperature of the room. The greater part of the paper contains results obtained with dilute aqueous solutions of non-electrolytes, including *n*-propyl alcohol, *n*-butyl alcohol, amyl alcohol, glycerine, acetone, dextrose, cane sugar, mannite, aniline, methyl alcohol, ethyl alcohol, and ether. All these, except

the last three, have the same value for the molecular depression, viz., 1·86. The van't Hoff constant is 1·87, but this difference might be accounted for by a small error in the heat of fusion of ice. As the concentration of the solutions increases, the molecular depression varies. This is not surprising when it is remembered that the solute is assumed to occupy a volume equal to that of the solution, like an ideal gas. In the equation of van der Waals a correction is introduced so as to allow for the space taken up by the molecules themselves. A similar correction in the case of solutions may be effected by defining the concentration in terms of gramme-molecules per 1,000 c.c. of *solvent*, instead of in gramme-molecules per 1,000 c.c. of solution. Upon recalculating the depression on this basis the author finds that the molecular depression is constant in the case of methyl and ethyl alcohol, glycerine, dextrose, mannite, and chloral hydrate (limits generally 0·01 to 0·20 grammes per litre). Want of constancy in the case of methyl and ethyl alcohol and ether may possibly be due to evaporation from the solution. W. R. C.

885. *Application of the Phase Law to Alloys and Rocks.* **H. le Chatelier.** (Comptes Rendus, 130. pp. 85–87, Jan. 8, 1900.)—The author first enunciates the phase law in the form $v = n + p - r$, where v = no. of degrees of freedom of system, n = no. of independent components, p = no. of variable physical parameters, and r = no. of phases. If temperature be the only physical parameter which is variable, then $v = n + 1 - r$. If we now consider a mixture of solid bodies at ordinary temperatures, obtained by a series of reversible transformations (such as solidification by cooling, crystallisation from a solution, &c.), the result will be a stable solid mixture whose temperature may be varied within finite limits without any one of the phases necessarily disappearing. Hence $v = 1$ and therefore $n = r$. We thus arrive at the proposition : "The stable state of a solid mixture obtained in this way is such that the number of phases present is equal to the number of independent constituents."

As an example of this proposition the author considers the gradual cooling of melted cast iron. The following stages occur : (1) Liquid, $r = 1$, $v = 2$. Temperature and composition variable. (2) Liquid + graphite, $r = 2$, $v = 1$. Composition of liquid a function of the temperature. (3) Liquid + graphite + solid solution of carbon ; $r = 3$, $v = 0$. Temp. = circa 1,150°. (4) Graphite + solid solution ; $r = 2$, $v = 1$. Composition of solid solution a function of the temperature. (5) Graphite + solid solution + pure iron ; $r = 3$, $v = 0$. Temp. = circa 700. (6) Graphite + pure iron ; $r = 2$, $v = 1$. Variation of temperature ceases to affect the state of the system, which now cools down to ordinary temperature without further change.

[These considerations are quite analogous to those introduced by van't Hoff and Meyerhoffer in their treatment of paths and end-points of crystallisation.]

As a further example we have granite with the *three* independent constituents—silica, alumina, and potassium oxide—and the *three* phases—quartz, felspar, and mica. If for any such solid mixture $r > n$, then some of the successive changes have been *irreversible*, and the solid mixture will not be stable. The two principal causes operating to produce such unstable mixtures are rapid cooling and solidification in successive layers, whereby certain parts become practically isolated. The author finally points out that in the case of metallic alloys such unstable solid mixtures are characterised by properties which vary greatly with the particular procedure followed in their preparation. F. G. D.

886. *Kinetics of Reactions with Secondary Action.* **R. Wegscheider.** (Zeitschr. Phys. Chem. 30. pp. 593–600, 1900.)—A secondary action (Nebenwirkung) is one in which the original substances forming the principal reaction are concerned, but suffer a different transformation to that of the principal reaction. A subsequent action (Folgewirkung) is one in which the products of the principal reaction react further. The author gives the differential equations for the case of secondary actions, and the solutions in certain cases. The mathematical reasoning does not admit of an abstract, but the following conclusions are arrived at: (1) If m reactions occur together, m differential equations are in general required to express the course of the action. The ratio of products formed in the different reactions is not independent of the time. (2) If in n of the reactions the same proportions of the reacting substances are involved, the number of differential equations is reduced to $m-(n-1)$. (3) If in two reactions the same proportions of the reacting substances are involved, the ratio of products formed in the two is independent of the time. The same is true if for any other reason (*e.g.*, appropriate catalytic action) the expressions for the velocities of two reactions differ only by a constant factor. And conversely such a constant ratio of products is a proof of the existence of a reaction with secondary actions of the properties stated. R. A. L.

887. *Ionisation Constants of Very Weak Acids.* **J. Walker** and **W. Cormack.** (Chem. Soc., Journ. 77 and 78. pp. 5–21, Jan., 1900.)—By means of a closed apparatus specially devised for use with solutions of gaseous substances, the authors have carefully determined the electrical conductivities of solutions of a number of compounds of an acid nature. Their results are shown in the following table, the first column of figures giving the ionisation constants, k, calculated by Ostwald's formula, and the second, the percentage ionisation in decinormal solution; the values for hydrochloric and acetic acids are added for comparison.

	$k \times 10^{10}$.	100 m.
Hydrochloric acid	...	91·4
Acetic acid	180,000	1·30
Carbonic acid	3,040	0·174
Hydrogen sulphide	570	0·075
Boric acid	17	0·013
Hydrocyanic acid	13	0·011
Phenol	1·3	0·0037

A single experiment with acetylene shows that its acid properties are very feeble, the dissociation constant being less than that of phenol. Although the values obtained by the authors for the conductivities and constants of the weakest acids are certainly too high, the errors are not great, as the numbers are in good agreement with the hydrolysis determinations of Shields (Phil. Mag. v. 35. p. 365, 1893). The bearing of the authors' results on those of previous observers is discussed in detail. T. H. P.

888. *Ionisation Constants of Weak Acids and the Hydrolysis of their Alkali Salts.* **J. Walker.** (Zeitschr. Phys. Chem. 32. pp. 137–141, Feb. 6, 1900.)—From the values obtained by Walker and Cormack (see preceding Abstract) for the ionisation constants of various weak acids, the author calculates the percentage of hydrolysed salt in 0·1-normal solutions of the acetate, bicarbonate, sulphydride, metaborate, cyanide, and phenolate of sodium. The numbers agree on the whole with those obtained by Shields (Zeitschr. Phys. Chem. 12. p. 167, 1893). T. H. P.

889. *Electrochemical Equivalents of Copper and Silver.* **T. W. Richards, E. Collins,** and **G. W. Heimrod.** (Amer. Acad., Proc. 35. pp. 123–150, 1899.) Metallic copper dissolves in an acid solution of copper sulphate, even when free from air and protected by an atmosphere of hydrogen, giving rise to cuprous sulphate; a deficiency is thus caused in the deposit of metal which is proportional to the area of the plate, and can be corrected for by extrapolating to a plate of zero area. In a neutral solution, on the other hand, the values are too high, owing to the deposition of cuprous oxide on the kathode; the solution employed must therefore be acid. By reducing the area of the kathode the error due to dissolution of the copper can be materially reduced, but if the current density becomes at all high, the weight of metal is reduced owing to the deposition of hydrogen in place of copper; this effect is most pronounced in dilute solutions, which might otherwise be employed with advantage to reduce the error due to dissolution of copper.

The best values for the electrochemical equivalent of copper are obtained only when the following precautions are used: (1) The solution must be cooled with a freezing mixture; (2) it must be acidified to prevent hydrolysis of the cuprous sulphate and precipitation of cuprous oxide on the kathode; (3) it must be as dilute as is consistent with preventing the liberation of hydrogen; (4) air must be excluded. By adopting these precautions and extrapolating to a plate of zero area the maximum atomic weight of copper has been found to be 63·563, taking that of silver as 107·93 and using the ordinary form of silver voltameter. Using a cupric solution already saturated with cuprous sulphate, higher values were obtained, viz., 63·573 at 0° and 63·615 at 60°.

The ordinary form of silver voltameter has been shown by a number of observers to give variable results owing to secondary actions, accompanied by the liberation of acid, at the anode. These sources of error are very largely eliminated by enclosing the anode in a porous pot instead of a filter-paper, and keeping the level of the liquid lower inside than outside the pot. Under these conditions the electrochemical equivalent of silver was found to be 0·0011173 grammes per ampere-second, and that of copper becomes 0·0003292 grammes per ampere second when the corrected value for silver is used; hence also 96,610 coulombs correspond to one gramme-equivalent of an electrolyte. The atomic weight of copper, determined from the corrected electrochemical equivalent is shown to lie between 63·598 and 63·615, and agrees closely with the value 63·604 obtained by chemical methods.

The paper contains full references to the work of Foerster and Siedel, Kahle, Patterson, and Guthe, and other workers on the subject. T. M. L.

890. *Ozone by Electrolysis.* **G. Targetti.** (N. Cimento, 10. pp. 360–365, 1899.) The author gives results of a number of experiments made in order to determine the best conditions for the production of ozone by electrolysis. His conclusions are: (1) Lead is the best metal for the electrodes; (2) the amount of ozone evolved per unit of energy expended is proportional to the current density at the anode; (3) the best concentration for the sulphuric acid is that corresponding to a density of 22° Bé (1·180); (4) oxygen containing the same proportion of ozone is evolved, whether the voltameter is kept at — 2° or + 17°; (5) a current of air injected into the liquid greatly increases the yield of ozone. Ozone cannot be produced economically by electrolysis, as by the expenditure of 1 H.P.-hour, about 2·73 grammes of ozone are obtained, whilst Andreoli guarantees 100 grammes, and by using high frequencies Otto has obtained as much as 154·9 grammes for the same amount of energy. T. H. P.

891. *Deposition of Silver-Cadmium Alloys.* **S. Cowper-Coles.** (Indus. and Iron, 26. pp. 69, 85, 102–104 and 164–165, 1899.)—A serial—incomplete—relating to the influence of current density, strength of electrolyte, ratio of metallic salts in solution, and presence of extraneous salts, upon the deposits of silver and cadmium obtained at the kathode by electrolysis of a solution of the double cyanide of these two metals. After an historical introduction, very full details are given of the experiments made by the author bearing upon the above points; and numerous tables and diagrams are printed containing the results. The articles are not adapted for useful abstraction, and the originals should be referred to by those interested in the subject. J. B. C. K.

892. *Electrochemical Behaviour of Silver Fluoride and of Fluorine.* **R. Abegg** and **C. Immerwahr.** (Zeitschr. Phys. Chem. 32. pp. 142–144, Feb. 6, 1900.)—The authors have determined the molecular conductivities, in ohm^{-1} cm.$^{-1}$ units, of solutions of silver fluoride. In the more concentrated solutions, this salt shows almost exactly the same dissociation as silver nitrate, whilst for dilutions greater than about 0·00516 normal, the values obtained for the molecular conductivity exceed the value, 0·1016, indicated by Kohlrausch and Holborn (Leitvermögen der Elektrolyte, p. 202) for solutions of infinite dilution; in these dilute solutions, then, hydrolysis takes place, owing to the slight electro-affinity of the silver ion. This high degree of dissociation of silver fluoride shows that the fluorine ions are possessed of very great electro-affinity, a conclusion confirmed by the value, 1·75 volt, of the decomposition E.M.F. of fluorine.

The authors find that perfectly neutral solutions of silver fluoride dissolve an appreciable quantity of silver oxide, and are then alkaline to litmus, although a saturated aqueous solution of silver oxide has a neutral reaction. This increase in solubility of silver oxide in water containing another silver ion is due to the formation of a complex ion of the probable composition Ag_2 AgOH. T. H. P.

893. *Villon Process for Manufacturing Alcohol.* (Elect. Rev. N.Y. 35. p. 375, 1899.)—The Villon process for the manufacture of ethyl alcohol is now in operation in Russia, and the product is being used as a fuel in motor vehicles. The raw materials of the process are limestone and coke. These are ground, and heated together in an electric furnace in order to produce calcium carbide. The carbide is then decomposed with water in the usual manner, and the resulting acetylene gas is converted into ethylene gas by allowing it to pass through a solution of chromium and ammonium sulphates, maintained at a temperature of 40° C. The ethylene gas is then absorbed in sulphuric acid, and the hydrogen-ethyl-sulphate obtained in this way is distilled after the addition of water. The distillate is condensed and is ethyl-alcohol of a very pure character. It is stated that with carbide at $20 per ton, the cost of the alcohol is 8 cents per gallon. Figures showing the apparatus used in this method of manufacture are given. J. B. C. K.

REFERENCES.

894. *Contact* v. *Chemical Theory.* (Elect. Rev. 45. pp. 1031–1034, 1899.)—Discussion of the theory of the Volta effect. W. R. C.

895. *Ionic Velocities.* **O. Masson.** (Roy. Soc., Phil. Trans. 192. pp. 331–350, 1899.)—A paper similar to that referred to in Abstract No. 258 (1900). W. R. C.

STEAM PLANT, GAS AND OIL ENGINES.

896. *Advantages of Superheating and the Superheater of Liège University.* **G. Duchesne.** (Amer. Electn. 12. pp. 75–76, Feb., 1900.)—A few authentic cases are cited of the increased economy due to superheating, and a description of the Liege superheater is given together with the results of some tests showing a saving due to superheating of 11·25 per cent. on an installation not designed to obtain economy. J. T. R.

897. *Dellwik-Fleischer Water-Gas.* (Engineering, 69. pp. 118–119, Jan. 26, 1900.)—All practical water-gas processes are intermittent, and consist in heating up the fuel by means of an air-blast, followed by the decomposition of steam by contact with the incandescent carbon thus heated. The older water-gas generators produce generator gas ($CO + N_2$) during the heating periods, which occupy about forty-five minutes of each hour, leaving only fifteen minutes for the water-gas production. The Dellwik-Fleischer water-gas generators are heated about ten minutes, giving only waste gas ($CO_2 + N_2$), leaving fifty minutes of the hour for the water-gas production, so that the yield of gas is more than double that obtained by the older processes. Vivian B. Lewes found by experiment that one ton of coke, containing 87·56 per cent., or 1961·8 lbs. of carbon, yielded 77,241 cubic feet of Dellwik water-gas, having a gross calorific value in Junker's calorimeter of 304 B.Th.U. per cubic foot. Hence the calorific value of this water-gas from a ton of coke was over 82 per cent. of the heating value of the total coke used in both generator and steam boiler, taking 20 per cent. of the coke as used for raising steam. Every 1 lb. of carbon yielded nearly 40 cubic feet of this water-gas composed of 51 per cent. hydrogen, 41 per cent. carbonic oxide, 0·5 per cent. of marsh-gas, 4·5 per cent. carbonic acid, and 3 per cent. nitrogen. During the last two years Dellwik water-gas has been used in the iron industry for firing the welding furnaces, and for tempering and annealing. On the Continent this water-gas is also used to increase the capacity of coal-gas works. The mixture of coal-gas and water-gas is enriched by benzol to the desired candle-power. The supply of benzol is steadily increasing from by-product coke ovens, and at the present time benzol-carburetted water-gas, as admixture to coal-gas, is produced in Germany at a lower cost than is possible with water-gas enriched by oil. As an enricher benzol is likely to supplant petroleum owing to the rise in the price of the latter.

Dellwik water-gas is one of the cheapest fuels for producing power by means of gas engines. One large gas engine firm is prepared to guarantee a consumption of 30·5 cubic feet of this water-gas per H.P. hour. With coke at 9s. per ton the gas costs only about 3d. per 1,000 cubic feet, and this makes the cost per hour of a H.P. about $\frac{1}{10}$d. for fuel. W. R.

898. *Tests of a Westinghouse Gas Engine.* **C. H. Robertson.** (Engineering, 69. pp. 135–140, Jan. 26, 1900. Paper read before the American Society of Mechanical Engineers.)—The author gives (1) a description with drawings of a 125 H.P. Westinghouse gas engine, using natural gas and driving a 60-kilowatt two-phase alternator; and (2) results of a five hours' test, under service conditions, with measurements of the power developed and gas

consumed, at Lafayette, Ind., in March, 1899. The three vertical cylinders 13 inches diameter by 14 inches stroke have a clearance of 21·28, and 21·59 per cent. The gas and air pass through a mixing-valve chamber, and the speed is controlled by throttling the charge. To start the engine compressed air is stored in a steel cylinder at 160 lbs. gauge pressure. One cylinder is converted into a compressed-air engine until speed is got up to slightly compress and fire a charge in the other cylinders by electric igniters. A gasoline vapour generator is installed to provide against interruption of the gas supply.

Chemical analysis of the natural gas used as fuel gave the percentage of methane 92, hydrogen 0·6, hydrocarbon 0·5, and carbon monoxide 0·55, with carbon dioxide 1·8, nitrogen 3·8, and oxygen 0·7. The exhaust pipe was red-hot, and its temperature by copper ball calorimeter was about 1,200° F. "Back-firing" or ignition of the incoming charge in the distribution pipe took place during the test. The highest speed in r.p.m. was 280, the lowest 265, and the average 270·86; or a variation of 5·5 per cent. The average I.H.P. was calculated from observations every five minutes. The efficiency of the alternator was known, and hence the B.H.P. of the engine. The highest mechanical efficiency was 84·6 per cent.

The tests showed the lowest and highest gas consumption in cubic feet per hour (reduced to 14·7 lbs. per square inch and 62° F.) to be 11·87 to 18·42 per I.H.P., 14·71 to 29·65, per B.H.P., and 16·52 to 40·59 per electrical H.P. By plotting the total gas per hour and the different I.H.P's. in each case a straight line can be drawn to represent the average gas consumption at different loads like Willans' law for steam engines, namely, that the total steam per hour plotted against the I.H.P. is a straight line.

The conclusions are: (1) That the proportion of gas to air is a very important factor in fuel economy; (2) that one test at a light and one at a heavy load would give the line, from which a prediction could be made of the gas consumption under intermediate loads; (3) these hold for the fuel consumption per B.H.P. hour and per electrical H.P. hour. The best thermal efficiency of the engine, that is, the B.Th.U. equivalent to the B.H.P., divided by the B.Th.U. in the gas consumed was 17·3 per cent.—not high for a gas engine. The heat distribution is shown by the following table:—

Time.	B.Th.U. supplied per hour.	Per cent. converted into indicated work.	Per cent. absorbed by jacket.	Per cent. lost by exhaust.	B.Th.U. per I.H.P. per minute.
1st hour.	1,574,200	17·9	25·2	56·9	237·5
2nd „	1,674,880	16·3	21·0	62·8	264·7
3rd „	1,169,000	20·7	30·2	48·9	294·2
4th „	1,096,600	20·2	36·9	42·7	211·1
5th „	828,000	16·0	50·3	43·9	259·3

The poor result during the first and second hour is due to the improper mixture of gas to air in the proportion of 1 : 11, then the ratio was changed to 1 : 12. The lowest consumption of gas per I.H.P. per hour was 11·87 cubic feet, giving 11,870 B.Th.U. at a cost of $0·07 (3½d.) per thousand cubic feet.

The main results and features of the trial are shown graphically. W. R.

899. *Liverpool Trials of Motor Vehicles; Judges' Report.* (Automotor Journal, 4. pp. 143–153, Jan., 1900.)—This is an abstract of the report of the

trials made at and near Liverpool in October, 1899, of six different heavy motor vehicles under the auspices of the Liverpool branch of the Automobile Club of Great Britain. There were entered for the trials eleven vehicles, and of these the six whose makers' names are given in the accompanying Table I

TABLE I.

Summary of Particulars.	Thornycroft No. 1.	Thornycroft No. 2.	Coulthard No. 3.	Leyland No. 4.	Clarkson & Capel No. 5.	Bayley No. 6.
Total moving weight laden and fully provisioned, including attendants—tons...	7·465	8·420 3·182	4·998	7·753	6·765	7·282
Mean moving weight laden and fully provisioned, including attendants—tons...	7·235	8·094 3·182	4·886	7·636	6·676	7·129
Mean tare, not including attendants —tons.....	3·582	4·004 0·737	2·524	3·141	3·359	3·469
Load carried—tons...	3·73	4·09 2·56	2·32	4·44	3·35	3·67
Ratio of mean tare to load.....	0·96	0·71	1·09	0·71	1·00	0·95
Declared B.H.P.	35	40	14	14	14	22
Mean tare per declared B.H.P—cwts.	2·04	2·37	3·60	4·48	4·80	3·16
Mean total moving weight per declared B.H.P.—cwts.	4·14	5·46	6·98	10·88	9·54	6·48

appeared and went through the trials. This table is an abstract of the whole of the most important results obtained during tests which included the transport of heavy loads over various good and very bad roads and hills, and over considerable distances. Table II. gives a summary of those figures which relate to cost per ton mile of goods carried. The tables together provide information which is a key to the whole report, all the vehicles being steam propelled.

TABLE II.—SUMMARY OF FACTORS AFFECTING THE COSTS PER NET TON-MILE.

Vehicle.	Prime Cost.	Load Carried.	Commercial Speed.	Fuel Consumption		Water Consumption		Cost of Motive Power per Ton-mile of Load.	Cost of Attendants per Ton-mile of Load.
			Miles per Hour.	per Vehicle-mile.	per Ton-mile of Load.	per Vehicle-mile.	per Ton-mile of Load.		
	£	tons				galls.	galls.	d.	d.
Thornycroft	590	3·73	5·31	8·88 lbs. coal.	2·38 lbs. coal.	7·15	1·88	0·27	0·44
Thornycroft	640	6·65	5·67	12·46 lbs. coal.	1·87 lbs. coal.	9·81	1·33	0·22	0·36
Coulthard...	400	2·32	4·78	...	...	...	...	...	...
Leyland ...	450	4·44	5·02	0·539 gall. oil.	0·121 gall. oil.	4·00	0·91	0·62 [1]	0·38
Clarkson ...	450	3·35	4·94	0·724 gall. oil.	0·216 gall. oil.	2·13	0·64	1·09	0·52
Bayley	600	3·67	4·93	6·76 lbs. coke.	1·84 lbs. coke.	4·65	1·27	0·13	0·65

[1] Last year's cost was 0·53d., kerosene being then at 4d. per gallon. If kerosene had been at 5d. per gallon as it is now, the cost for last year would have been 0·66d.

W. W. B.

900. *New Carburettors.* (Automotor Journal, 4. pp. 209–210, Feb., 1900.)—A detailed description with sectional drawings of three new petrol carburettors

for oil motors. Parsons' carburettor contains wicks of a porous fabric, which are kept partially saturated with petrol and through which air is drawn. Provision is made for the variably controlled admission of fresh air which mixes with the carburetted air before passing to the motor cylinder. It is stated to be a somewhat complicated apparatus. The Le Blou and the Abeille carburettors are both modifications of the well-known pulverising constant level type, but are intended to produce a more homogeneous mixture of air and petrol and to be more accurately adjusted. A. G. N.

901. *French Motor Trials.* (Automotor Journal, 4. pp. 202–203, Feb., 1900.)—The results are given of tests carried out by *La Locomotion Automobile* to determine the actual power of oil motors as attached to motor-cars. Two tables of results are included. The first refers to the motors only—make, type of carburettor, cylinder dimensions, brake test weights, speed, and B.H.P. The second refers to the cars complete—weight on driving wheels, speed, brake test weights, B.H.P. at driving wheels. The cars were fixed in such a manner that the driving wheels rested on a roller, which they caused to revolve, and which was fitted with a power-measuring brake. Very few of the motors in table (1) correspond with vehicles in table (2), so that the efficiencies of the gearing can be only obtained very approximately. An increase of output appears to accompany the use of a spraying carburettor as compared with a mixing (gasifying) one. Their relative efficiency is not shown. The use of an exhaust silencer is shown to considerably reduce the output of the motors. The B.H.P. of the motors tested varies from 1·32 to 10·5, and the weight on the driving wheels of the cars tested varies from 200 to 500 kilogrammes. The motor speeds vary from 623 to 2,057 r.p.m., and their dimensions from double cylinder 110 mm. bore, 160 mm. stroke, to single cylinder 66 mm. bore, 70 mm. stroke. A. G. N.

902. *Heavy Motor Waggons for Liverpool Traffic.* **A. Musker.** (Automotor Journal, 4. pp. 153–159, Jan., 1900. Paper read before the Liverpool Engineering Society on Dec. 15, 1899.)—The author describes the main features of a lorry and its mechanism designed by his firm for heavy work, namely, to carry 5 or 6 tons on a tare weight of 3 tons. One main feature of the design is an arrangement by which the lorry platform is clear from end to end of all obstructions in the form of either boiler or machinery. An experimental lorry has been made driven by a four-cylinder single-acting high-pressure engine supplied with steam by a boiler consisting of three coils of steel tube acting on the Serpollet system. The boiler is fired by an oil burner, and the oil and air and the water supply are automatically controlled with reference to steam pressure and with relation to each other. This is done by one combined auxiliary fan engine pump. The transmission gear consists of a spur gear driven countershaft, carrying sprocket wheels for chains which drive the road wheels. A new form of oil fuel burner is described but not shown. A useful table is given with the paper, comprising a list of twenty-four different kinds of freight with the space occupied on a lorry platform, number of packages, and total load. W. W. B.

903. *Serpollet Superheated Steam Motor.* (Automotor Journal, 4. pp. 212–214, Feb., 1900.)—This article describes the recent form of high-speed engine single acting, designed for use with high pressure and highly superheated steam by Serpollet. A feature of the engine, which has two opposite

cylinders, connected by rods to a single crank, is the use for steam admission of small mushroom valves actuated as they are in gas engines, and having rods passing through long guide bosses without any packing; the rods are actuated by rotating cams which may be placed at either end of the shaft carrying them so as to present cam projections which are in the necessary relative positions for running the engine in either direction. Exhaust is by outlet ports uncovered by the pistons at the end of the stroke. W. W. B.

904. *Recent Experiences with Steam Vehicles.* **J. I. Thornycroft.** (Feilden, 4. pp. 429–441, 1899.)—This paper commences with a reference to the present legal restrictions on the use of the heavier kinds of motor vehicles under the Locomotive and Highways Act of 1896, and points out that the regulation relating to the deduction of the weight of the fuel and water from the total weight of the vehicle acts very unfavourably against the steam and oil vehicles as compared with the electrical vehicles, the weight of the accumulators in which is deducted from the total weight of the vehicle though it may be as much as half the whole weight. The author points out that to put the steam vehicles on the same basis, the boiler and its water, which corresponds with the battery and its electrolite, should be deducted. He urges, however, that instead of fixing arbitrarily upon a definite tare weight, a maximum load per inch width of tyre would provide better against undue damage to roads; though it would indeed be better to remove all such restrictions, thus placing English makers and users in the position of those in France. His experience leads him to the opinion that a quite satisfactory steam-driven vehicle for 3 tons can be built to a tare of 4 tons and maintain a "commercial speed" (average speed including stoppages) of six miles per hour. In the remainder of the paper the author describes eight different forms of Thornycroft heavy steam vehicles, illustrated by photographs, including those of the most recent and highly successful drays, all of which are driven by gearing instead of by the chains formerly used. The paper concludes by a further expression of opinion as to the necessity for raising the 3 ton tare limit, and concerning the assured ultimate success of the modern high-road motor waggon. W. W. B.

905. *Simpson-Bodman Steam Lorry.* (Indus. and Iron, 28. pp. 35–37, Jan. 19, 1900.)—Describes the construction and working system of this heavy type of motor-car. It weighs nearly 3 tons, can carry 3½ tons load, and has an area of 78 square feet for carrying goods. Two independent engines are used, each capable of giving 8½ B.H.P. at 500 revolutions per minute with 100 lbs. steam pressure. Three sets of pinions, giving ratios of 10, 13, and 24, are provided between the engine shafts and the driving wheels of the car; when the car is at rest either set of pinions can be connected for use. The steam generator is built up of indented weldless steel tubes into which the water is forced in accordance with the pressure required. It is intended to allow the boiler to be dry when any long stops are required, a hand pump being provided for restarting the system. The driver normally controls the propelling mechanism by varying the water pump feed. Working steam pressure varies from 100 lbs. to 250 lbs. per square inch, but the temperature of the tubes is usually 600° to 1,000° F. A steam drum is provided, and through this passes a feed water heater. The exhaust steam from the engines is first passed into a silencing chamber and is then superheated by the boiler furnace and ultimately passed in an invisible form to the atmosphere through a nozzle which creates a draught for the fire. A. G. N.

906. *Automobiles.* **Cuénot** and **Mesnager.** (Écl. Électr. 21. pp. 420–423, 1899. Paper read before the Assoc. Française at Boulogne.)—After giving some historical notes, the authors remark that France is ahead of the world in automobilism owing to liberal laws which make no limit of weight, or width, or speed under 30 kms. per hour, provided certain tests are passed as to brake, steering, and the driver's capabilities. The total tractive pull on an average road is a fraction of the weight given by 0·033 + 0·0006 V on solid rubber tyres, and 0·025 + 0·0004 V on pneumatic tyres (where V is velocity in kms. per hour). The total weight in kgms. of any automobile ready to travel for H hours is as follows, per H.P. delivered to the wheels :—

Motor "Field"	85 + 33H
Motor with water-tube boiler	67 + 22H
"Serpollet" motor with coke.....	92 + 13H
„ „ „ petrol	83 + 11H
Petrol explosion engine	67 + 0·83H
Electric motor and accumulators	66 + 49H

M. O'G.

907. *Motor-Cars.* (Automotor Journal, 4. pp. 173–175, Jan., 1900. Excerpt of a paper by **A. Craig** before the Cycle Engineers Inst., Coventry, Dec. 14, 1899.)—Electric ignition is preferred to all others. De Dion's mechanical trembler coil, and Simms' magneto generator are described.

Surface carburettors are protected from explosion by fine wire gauze between the petrol and the engine. Preference is given to the method of injecting the exact portion of oil required into the air which is entering the cylinder. A gradually variable gear without slipping is being attempted, (1) by taper cone pulleys with belt ; (2) expanding pulley ; (3) conveying the motion from the engine to the road wheels by an intermittent feed. M. O'G.

REFERENCES.

908. *Progress of Steam Engine.* **R. H. Thurston.** (Cassier, 17. pp. 191–199, Jan., 1900.)—An historical article, dealing with the progress of the steam engine. It contains curves showing the rate of change in ordinary practice as regards piston speeds, steam pressures, efficiencies, &c., throughout the century.

909. *Large Electric Lighting Engines.* **R. D. Summerfield.** (Elect. Engin. 25. pp. 6–7, Jan. 5, 1900.)

910. *Valve Motions of Engines.* **J. Perry.** (Nature, 61. pp. 152–153, 1899.)—Description of a geometrical construction invented by J. Harrison to show the relative positions of piston and valve. J. T. R.

911. *Oil Engines and Motor-Cars.* **A. G. New.** (Engineer, 89. pp. 1–2, Jan. 5, and pp. 29–30, Jan. 12, 1900.)

GENERAL ELECTRICAL ENGINEERING.

912. *Harris Watt-hour Meter.* (Elect. World and Engineer, 35. pp. 188–189, Feb. 3, 1900.)—The meter consists of four parts: An electro-dynamometer, of which the fixed coil takes the main current, and the movable the shunt current; a clockwork mechanism arranged to run for a definite short time; a "recording" cylinder rotated by the armature of an electromagnet in shunt across the mains, its circuit being closed every time the clockwork runs down and the armature at the same time rewinding the clock-spring; and an integrating train driven by a cylinder parallel to the recording cylinder. The recording cylinder drives this through a small roller attached to an arm on the movable coil of the dynamometer, the roller taking up some position between the ends of the cylinder, corresponding to the currents passing through the dynamometer. The recording cylinder has a wedge-shaped portion cut down which does not gear with the integrating cylinder through the roller, so that when the roller is at one end, corresponding to full load, the cylinders are in gear throughout the revolution, while at the other end, corresponding to no load, they do not gear at all.

The movement of the integrating cylinder is thus proportional to the deviation of the dynamometer coil, which is in turn proportional to the power. G. H. B.

913. *Fusible Cut-outs.* **B. H. Glover.** (Street Rly. Journ. 15. pp. 888–889, 1899. Paper read before the Chicago Electrical Association, Nov. 17, 1899.)—A cut-out consists of three principal parts: (*a*) The base and its cover; (*b*) the terminals; and (*c*) the fuse. The base should be well glazed porcelain and a cover for the base should always be used. The terminals should not be too near to each other. Careful experiments show that the best lengths of fuse are as follows:—

For 3 to 5 amperes	2·5	inches
For 10 to 15 amperes	3·5	„
For 20 amperes	4	„

and for each additional 5 amperes an increase of 0·5 inch in the length. For sudden heavy overloads a multiple fuse of several small wires is much more sensitive than one large one of the same capacity, and a thin, flat ribbon is better than a round fuse. W. G. R.

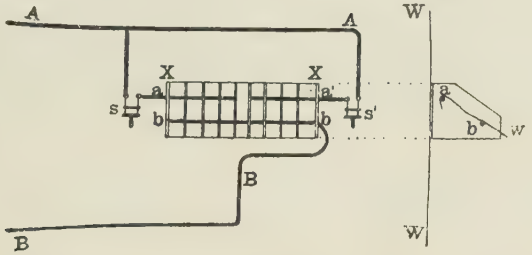
914. *Submarine Cable Breaks near previous Repairs.* **A. Gray.** (Inst. Civ. Engin., Proc, 138. pp. 350–352, 1899.)—After a repair, the dragged portion of cable remains in tension owing to the elasticity of the material and the absence of slack. Corrosion (probably due to abrasions in dragging) starts, and rupture results. M. O'G.

915. *Arched Cement Cable Conduits.* **C. H. Sewall.** (West. Electn. 25. pp. 280–281, 1899. Paper read before the Chicago Electrical Association, Oct. 6, 1899.)—A single subway in the middle of a street is impracticable because of its excessive cost, and because it requires connection under the streets to the private lines, and so does not do away with cutting up and

repairing streets. A draw-in system made by standing thin arches of cement without any bottom on a 3-inch cement floor is recommended. The arches are only $\frac{3}{16}$ inch thick on a wire gauze support, and the whole is surrounded in concrete, which sets to the cement arch.

Two hundred pairs of telephone paper cables are now made into a cable $1\frac{1}{2}$ inches over the lead; and three No. 0000 wires for a working pressure (three-phase) of 11,000 volts are made into a cable slightly more than 2 inches diameter. M. O'G.

916. *Simple Lightning Arrester.* **A. E. Kennelly.** (Amer. Electn. 11. p. 572, 1899.)—A simple and convenient form of lightning arrester has been designed by W. T. Cooke of Louisville, Ky., for use in central stations. The arrester is shown in front elevation and vertical section in the figure. Upon the wall, W W, of the station, near the switchboard, is a box, X X, with nine vertical partitions, each lined with asbestos paper. Into this box pass three copper rods *a*, *a'*, and *b*. The two former are connected through



switches, *s*, *s'*, with a heavy copper conductor leading directly to the positive 'bus bar of the switchboard. The lower rod, *b b*, is connected directly to the negative 'bus bar by a copper conductor without any switch. In any partition of the box a No. 16 double cotton-covered copper wire is hung. The upper end of the wire is bared and is hooked around the rod *a*, while the lower end is left covered and is allowed to rest by its weight on the ground rod *b*. The cotton covering will stand the 550 volts of the dynamos, but gives way under the pressure of a lightning discharge. W. G. R.

917. *Silicium Bronze and Aluminium Alloy for Wires.* **Massin.** (Écl. Électr. 22. pp. 140–141, Jan. 27, 1900. Annales télégraphiques, 25. pp. 200–204.)—This is an investigation of the qualities of the above alloys for use for overhead wires. The percentage compositions are not given. The densities are as 8·9 to 2·8, the breaking strains 75 and 28 kilos. per square mm., the conductivities as 41 to 48, and prices per kilogr. 2·85 fr. and 5·00 fr. respectively. Aluminium bronze, as well as aluminium, is more readily attacked than is generally supposed. Acid tests are described. The author finds that the aluminium alloy has larger coefficients of dilatation and elasticity than silicium bronze, and is consequently less suitable for use where strains and dips due to fluctuations of temperature have to be considered. The relative corrodibility is also a disadvantage. But, as has been stated above, the composition of the alloy is not given. E. O. W.

918. *Electric Welding.* **H. Lemp.** (Elektrochem. Ztschr. 6. pp. 159–169, 1899.)—The author first describes early methods of electric arc welding, in which the heat is obtained from an arc, and is very intense and localised.

Only a small surface of metal can be treated, and it is very liable to overheating. This is avoided in the method of welding introduced by Elihu Thompson, in which a very large current at a low voltage is passed through the metal, which is thus uniformly and intensely heated, owing simply to its ohmic resistance. The apparatus required is described and illustrated. The action of the alternate current transformer is explained on the analogy of friction wheels of different diameters. Details of the consumption of energy are given, showing the high efficiency of electric heating as compared to forge heating. The possible sources of energy and the various industrial applications of the process are described, including wire-making, welding on spokes of iron wheels, welding and bending pipes, and welding rail-joints. (See 1899, Abstract No. 1989.) L. B.

919. *Electricity in Gasworks.* **H. G. Field.** (Amer. Electn. 11. p. 573, 1899. From "The Technic.")—The Detroit City Gas Company has installed at its works a small electric lighting plant for the purpose of lighting certain rooms of the works where, owing to the inflammable and explosive nature of the atmosphere, naked lights are out of the question. An illustrated description is given of an apparatus for recording or indicating the gas pressure as measured either anywhere on the premises or at any distant point. It consists of a small gas-holder, to the bell of which is attached a contact arm sliding over a set of studs. Between the studs are resistance coils, through which a certain constant current is passed. The potential difference between the contact arm and one of the extreme studs is proportional to the height of the bell, that is, to the gas pressure. This potential difference can of course be tapped off to a number of recorders or indicators at any distance. E. D. P.

920. *Electrical Heating.* (Elect. Rev. 45. pp. 954–955, 1001–1002, 1899.)—Electrical heating for certain purposes is undoubtedly expensive and extravagant, but there are many purposes also to which it can be applied where electricity will be found cheaper than other methods. The points to be considered, when comparing electric heaters with others, are given. The everyday uses to which electrical heating can be applied with advantage are considered, such as : (1) Flat-irons for laundry purposes ; (2) rolls for laundry work ; (3) goffering-iron heaters for laundries, dye-works, &c. ; (4) hot-plates and glue-pots for wood-workers' shops ; (5) hot-plates and stoves for lacquering purposes ; and (6) goose irons for tailors. The advantages of electricity for use in all these cases are given in detail ; the chief points being —cleanliness, fire-risks, efficiency, regulation of temperature, and quantity of work turned out.

For cooking purposes the use of electricity will not cost an excessive amount if current can be purchased at 1d. or 1½d. per unit, and if some other means is provided for heating the usual large quantity of water required for domestic purposes. Electrical radiators for small rooms and for intermittent heating, even when supplied from central stations, will compare favourably with other forms of heating. With rooms over 5,000 cubic feet in size, and in rooms where continuous heating is required, electrical heating becomes too expensive. The average power required for heating a room is about 500 watts per 1,000 cubic feet of volume ; and during the coldest weather this power will be required for two or three hours to raise the room temperature to about 65° F. The power may afterwards be reduced to about ⅓ or ½. The best design of radiator is one which has a free draught and circulation of air through it. The first cost of radiators per 100 cubic feet of room

volume is given as: 6s. for rooms up to 1,000 cubic feet in volume, 4s. 6d. for rooms up to 2,500 cubic feet in volume, and 3s. 6d. for rooms up to 5,000 cubic feet in volume.

It may be taken as a general rule that, if the degree of temperature required for an operation exceeds 500° F., there will be difficulty in making electrical heating apparatus durable and satisfactory for general working.

E. D. P.

921. *Paris Electric Fire Engine.* **J. Reyval.** (Écl. Électr. 20. pp. 456–458, 1899.)—The author describes and illustrates this car which, so far, has been successful. The weight of accumulators is 520 kgs. M. O'G.

922. *A 35-ton Electric Travelling Crane.* (Écl. Électr. 21. pp. 389–391, 1899. Génie Civil, xxxv. p. 408, Oct. 21, 1899; from the Zeitschrift des Vereines Deutscher Ingenieure.)—A description and drawing of a heavy overhead 3-motor traveller, having a span of 16 metres in a boiler shop. The 15 H.P. hoisting series motor raises loads of 20 to 35 tons through 1·3 metres per minute, and higher loads at 2·7 m. per minute. The bridge is travelled at 40 m. per minute by a 10 H.P. series motor carried at the centre, and the carriage at 15 m. per minute by a 5 H.P. motor. An electric brake is automatically applied when the motor is stopped, and removed on starting up. The hook is double; it turns on ball bearings and is carried by three chains.

E. H. C.-H.

923. *Electric Travelling Cranes.* (Engineering, 69. pp. 13–15, Jan. 5, 1900.)—The most advanced practice in overhead travellers is to use a separate reversing motor for each motion; the paper describes and illustrates a 50-ton crane so constructed by J. Adamson & Co., of Hyde, Cheshire. The crane has four motors to drive the main barrel, the light barrel, the longitudinal motion, and the transverse motion respectively, with current at 220 volts. The main lifting speed is 4 feet per minute, the lifting barrel being 2 ft. 6 in. diameter, the corresponding motor running at 400 r.p.m., and there being three intermediate shafts between the motor and the barrel. The light lift is intended for loads up to 5 tons, the speed of lifting is 15 feet per minute and the speed of the motor 300 r.p.m. The speed is reduced at two steps by a worm gear and a pair of spur-wheels, the worm gear running in an oil bath. Both lifting drums are controlled by electric brakes. The brake wheel is pressed on by shoes applied by springs and released by an electromagnet which is energised when the current is directed to the corresponding motor. Should the current fail from any cause the brake goes on immediately and holds the load; on the other hand, immediately the crane is set to lift or lower, the brake is taken off. Should the load in falling drive the motor too rapidly, the back electromotive force reduces the current and the brake goes on of itself. The longitudinal travel of the crane takes place at a speed of 80 feet per minute, the speed of the motor is 300 r.p.m., and the reduction is effected in two stages. The transverse motion is at 40 feet per minute, and the motor runs at 500 r.p.m. The power absorbed by the motors when the crane is fully loaded is as follows: Main hoist, 25 B.H.P.; auxiliary hoist, 12 B.H.P.; traversing, 7 B.H.P.; longitudinal travel, 5 B.H.P. Curves are given showing the efficiency of the main and auxiliary hoisting gears at various loads. At 30 tons' load the efficiency of the main hoisting gear attains its maximum value of 63 per cent.; the efficiency falls to 56 per cent. for the full working load, 50 tons. The maximum efficiency of the auxiliary hoisting gear is 55 per cent., the corresponding load being 3½ tons. A. S.

924. *Modern Mine Haulage Practice.* **H. K. Myers.** (Eng. Club Phil., Proc. 16. pp. 221–237. Discussion, pp. 237–239, 1899.)—This paper deals with the applications of locomotive power to haulage in mines, describing steam locomotives, compressed air locomotives, and lastly electric locomotives. Some striking figures as to the mileage of underground haulage ways and haulage miles per annum in some mines are given. It is estimated in the United States there are 50,000 miles of mine track utilising 100,000 mules, whose average life is only four years, the haulage costing 15 cents (7½ pence) per ton mile. Descriptions of the various locomotives and their performance are given, among others of electric locomotives by the Balmin-Westinghouse Co., by the General Electric Co., and others. One of these machines in practice is found to replace 24 mules and 12 men, saving $8,000 (£1,600) per annum. **Ll. B. A.**

925. *Electrically-driven Jacks.* (Elect. Rev. 46. p. 345, March 2, 1900.)—In the locomotive works at Nippes, in Germany, each 12-ton jack was manned by five men ; to raise a four-axle locomotive required 21 men for the four jacks. The average time for the lifting was 45 minutes and for the lowering about 30 minutes. In consequence of the variations in the time for each lift, depending on the willingness of the workmen, mechanical power for the operation of the jacks was introduced. Rope driving was tried and discarded. Compressed air and electrical power were both available at the works and were both tried. In comparison with the electrical gear the compressed air gear was complicated, and the cost of the electrical energy consumed was less than the cost of the compressed air used.

The electric motor used is mounted on a small car, the two jacks at one side of the locomotive are connected to the motor by solid spindles sliding in a hollow shaft on the feather and groove principle, a Hooke's joint being introduced to compensate for inequalities of level. The other two jacks are driven by chain gearing. The motor is of 5 H.P., and by means of main and shunt-circuit resistances has a range of speed from 300 to 1,035 r.p.m. Absolute evenness of lift by each jack is ensured in this way, and a considerable saving in time and labour is effected. The time occupied in raising a locomotive is 12 minutes, the lowering taking about the same time. At 110 volts a current of 35 to 38 amperes is required for raising and 20 to 25 amperes for lowering. The labour, including the shifting of the motor, can be supplied by two men.

Taking wages at 5d. per hour and electric energy at 2d. per kw. hour, the cost for hand manipulation works out at 10s. 11d., as compared with 6¾d. for electric driving. Interest, depreciation, and maintenance are not taken into account in this comparison. Allowing 1s. per hour for this amount, as representing a fair amount for a capital outlay of £600, the saving effected by electrical driving would be almost 10s. per lift. **E. D. P.**

REFERENCES.

926. *Standardisation of Electrical Plant and Testing.* (Amer. Instit. Elect. Engin., Trans. 16. pp. 275–288, 1899. See also 1898, Abstract No. 1089.)—Report of Committee appointed by the American Institute of Electrical Engineers.

927. *Comparative Advantages of Electricity, Steam, and Compressed Air for Mining Purposes.* **H. S. Childe.** (Instit. Civ. Engin., Proc. 138. pp. 432–435, 1899 ; also Engineer, 87. p. 641.)

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

928. *Disposition of Three-Phase Transmission Lines.* **A. J. Bowie, Jr.** (Journal of Electricity, S.F. 8. pp. 105–107, 1899.)—The author states that to eliminate inductive effects it is sufficient to spiral the three wires so that each occupies the middle position for one-third of the length of the line.

W. G. R.

929. *Electrical Plant on Warships.* **J. K. Robison.** (Eng. Mag. 18. pp. 209–222, 1899.)—The author discusses the possible gain due to the use of electricity for all power purposes on warships, with especial reference to their steaming radius. The efficiency of conversion from I.H.P. to B.H.P. is assumed to be 59 per cent., and the steam consumption under the best conditions 26 lbs. per I.H.P., whence there results a saving of 6 per cent. of the total steam used for all purposes. On the other hand, allowing electro-motors to have 1·5 times the rated power of the steam engines displaced, for equal torque, and taking a suitable value for the size of the generating plant, it is stated that the electrical machinery would weigh $3\frac{1}{2}$ times as much as steam plant. The resulting loss of coal tonnage being $10\frac{1}{2}$ per cent., the author concludes that electric transmission is inadmissible at present. The development of steam turbines and increased efficiency of conversion offer possible solutions to the problem. [See also Abstracts Nos. 994 (1898), and 759 (1899).] A. H. A.

930. *Electrical Plant on Warships.* (Mech. Eng. 4. pp. 787–788, 1899.)—In the annual report of the engineer-in-chief of the navy of the United States of America, the use of electrically driven auxiliaries is deprecated, chiefly on the score of weight and space occupied, but also on account of the increased complication and liability to break down. On the battleship *Alabama* the lighting dynamos occupy a space of 10,140 cubic feet, with a capacity of 250 kw. If the plant were increased sufficiently to operate all the auxiliaries, the extra space occupied would be sufficient to accommodate 900 tons of coal, giving 45 per cent. greater coal endurance. (See also 1900, Abstract No. 323.) A. H. A.

931. *Electrical Equipment of SS. "Oceanic."* (Amer. Electn. 11. pp. 501–504, 1899. Also described in Electrician, 44. pp. 352–354, Jan. 5, 1900.)—This is a description of the electrical equipment of the steamship *Oceanic*, of 30,000 tons. The voltage of the four dynamos is controlled by varying the speed, by altering the tension of a spring in the throttle governor mechanism, or by the stop valve. The negative pole of the dynamos is earthed to the shell of the ship. The equaliser switch forms part of the main dynamo switch, closing before the main switch itself. The load consists of 2,000 glow lamps, about 12 motors for fans, 200 electric heaters, and various cooking and other appliances. The telephonic and signalling apparatus are briefly described. A. H. A.

932. *Electric Power for Small Users in a 25-mile Radius.* **L. Bell.** (Eng. Mag. 18. pp. 239–248, Nov., 1899.)—The example of the three-phase dis-

tribution at 5,200 volts at St. Victor-sur-Loire is taken, where 1,400 H.P. is distributed to 2,500 looms belonging to small ribbon weavers. The lamp pressure is 110 volts, and pressure for motors is 190 volts. A water-power scheme costing £40,000 is sketched out and the profit on a £10 per H.P. annum rate is estimated. M. O'G.

933. *Cambridge Electricity Supply Works.* (Elect. Engin. 25. pp. 42–49, Jan. 12, 1900.)—The current at 2,000 volts pressure is generated by alternators driven by Parsons' steam turbines; steam at 140 lbs. per square inch being supplied from Lancashire boilers 30 feet long and 8 feet diameter.

A recent increase of plant is a 500 kw. set of dynamo and turbine, the tender for this being considerably below any of those for dynamo and high-speed engine. An equally important consideration is that the space available would not accommodate one engine set, while it is sufficient for two turbine sets. This turbine is of the parallel flow type, and runs at 2,700 revolutions per minute. It is governed electrically, and drives its own air and circulating pumps by means of worm gearing. The consumption of steam per kw.-hour was guaranteed not to exceed 27 lbs. at full load or 30 lbs. at half load, with steam pressure at 140 lbs. per square inch.

Tests at various loads gave the following results:—

Boiler pressure	127	139	145	140
Vacuum	24·75	24·5	26·5	27·5
Water per hour, lbs.	13,400	12,675	7,029	5,180
Output, kilowatts	598	426·4	256·1	124
Water per kilowatt-hour	22·4	24·1	27·5	33·7

H. R. C.

934. *Electric Installation of the Antwerp Railway Station.* **L'Hoest.** (Assoc. Ing. Él. Liège, Bull. 10. pp. 213–222, 1899.)—On account of the want of space at the Antwerp railway station, it was found necessary to build the electric generating station in connection with it at Berchem, at a distance of about 1,500 metres from it. The electric supply is for lighting the passenger station, the large number of shunt lines extending as far as Berchem, the secondary railway station at Berchem, the important adjoining works, and the goods station of Borgherhout. The station also supplies electrical energy for the hydraulic plant of the passenger station, which includes luggage lifts and electric ventilators for the coal conveyer, as well as for the motors of a repairing shop and feed pumps. The mixed system of lighting and traction extends over an area of more than 2½ kilometres, and includes motors which work intermittently, arc lamp regulators, and, at the furthest point, a load of about 700 incandescent lamps. A complete diagram of connections is given of the system employed, which consists of a continuous current three-wire distribution at 330 volts between the inner and outer wires, boosters and batteries being employed for balancing purposes. L. J. S.

935. *Hydro-Electric Installation of the East Antwerp Railway Station.* **Mélotte.** (Assoc. Ing. Él. Liège, Bull. 10. pp. 222–232, 1899.)—The electric station at Berchem delivers current at 330 volts to East Antwerp to drive 10 kw. shunt motors coupled to hydraulic pumps, which force water at 25 atmospheres into accumulators for the purpose of working hydraulic lifts. Eleven of these lifts are for raising loads of 1,400 kilogrammes and four others for raising 1,000 kilogrammes.

Hydraulic lifts were used in preference to electric lifts owing to the fact that apart from the above lifts it was necessary to employ elevators for raising railway trucks weighing 18 tons at a speed of 50 centimetres per second, which would have necessitated the use of electric motors of too large a size.

L. J. S.

936. *New Plant at Niagara.* (Amer. Electn. 11. pp. 547–551, 1899.)—A description of recent additions in the power house of the Niagara Falls Hydraulic Power and Manufacturing Company. A direct current machine, built by the General Electric Company, having an output of 5,000 amperes at 175 volts, has been installed. This machine has a commutator at each end of the armature, the two sets of brushes are coupled in parallel, the division of the load between the commutators being accomplished by varying the lead of one or other set of brushes. The division of the load is shown by a Weston ammeter coupled across the similar brushes of the two commutators.

This machine is coupled at one end of a shaft driven by a pair of wheels of the Jonval type. The wheels are 60 inches in diameter and are rated at 3,000 H.P. for the two, when running at 250 revolutions per minute under a head of 210 feet. Coupled to the other end of the shaft is a Walker alternator for incandescent lighting. It is of the revolving field type, is single-phase, has an output of 900 kw. and a frequency of 125. A shunt-wound generator, by the General Electric Company, 200 kw. and 135 volts, has been installed.

Two new and complete sets of turbines and generators for the Pittsburg Reduction Company have just been completed. The generators, two of which are coupled to each set of turbines, have each an output of 2,500 amperes at 300 volts.

These new sets of plant are all described fully, illustrations are given, and also a short account of further proposed extensions. The total capacity of the plant at present is 9,560 kw. [See Abstracts Nos. 1404 (1898) and 924 (1899).]

E. D. P.

937. *Alternate-Current Power Transmission at Sihl, Rathausen, and Olten-Aarburg.* **C. du Riche Preller.** (Engineering, 69. pp. 37–40, Jan. 12, 1900.)—The three installations which the author describes are those of the Sihl Works (Canton Zurich), the Rathausen Works (Canton Lucerne), and the Olten-Aarburg Works (Canton Aargen), all of which utilise their full hydraulic power, and therefore constitute interesting examples of self-contained central stations transmitting and distributing energy over large areas and for the most varied purposes.

(1) The *Sihl Power Transmission* is situated on the river Sihl about 16 kilometres from Zurich, and utilises the power of that river, the available average volume being about 3 cubic metres per second, at a fall of about 70 metres, equal to 2,000 effective H.P. on the turbine shafts. The power station contains five 400 H.P. high pressure turbines, coupled to superposed two-phase 5,000-volt alternators. The average power required for lighting amounts to 784 H.P. on the turbine, or 575 effective H.P. at the lamps, so that of the total number of lamps installed, about three-fourths burn simultaneously as a maximum, the total efficiency being 74 per cent. The average power required for the motors is 786 H.P. on the turbines, equal to 582 effective H.P. at the motors, the total efficiency being the same as that of the lighting system, viz., 74 per cent. The aggregate installed power of the motors is utilised by consumers to the extent of about 62 per cent., the surplus power being in many cases reserved for future requirements. The mileage of primary transmission is

equal to 40 H.P. of installed power (lamps and motors) per kilometre, or 64 H.P. per mile. Apart from the fifth turbo-alternator set, which is kept as a reserve, there is a 300 H.P. steam-alternator as a further reserve. The total cost of construction, transmission, and distribution, works out to £42 8s. per H.P., and the net earnings amount to 5 per cent. on the capital.

(2) *Rathausen Power Transmission.*—The power station is situated on the river Reuss, about 4 kilometres from Lucerne. The average water power utilised is 3–4 cubic metres per second at a fall of 4–5 metres, equal to 1,500 effective H.P. on the turbine shafts. The power station comprises five turbines of 300 H.P. each and five superposed 3,500-volt two-phase alternators. A reserve 300 H.P. steam alternator has also been installed. The aggregate installed power (lamps and motors) is close upon 1,000 H.P., the average power supplied at the time of maximum consumption being 1,300 H.P., or at 74 per cent. of the system, 1,800 H.P. on the turbine shafts. The power actually paid for by the consumers amounts to 1,400 H.P. The mileage of primary transmission is equal to 70 H.P. of installed lamps and motors per kilometre, or 112 H.P. per mile. The total cost of construction, transmission, and distribution works out to £47 4s. per H.P. The net revenue amounts to 5 per cent.

(3) *Olten-Aarburg Power Transmission.*—The power station is situated on the river Aare, about 4 kilometres south of the well-known Olten Railway Junction. The average water power utilised is 100 cubic metres per second at a fall of 3 metres, equal to 3,000 effective H.P. on the turbine shafts. The power station contains ten low-pressure turbines of 300 H.P. coupled to 5,000-volt alternators, while two other 5,000-volt alternators are actuated by two turbines each. The aggregate power of the installed lamps and motors, therefore, amounts to 1,800 H.P., or, at 74 per cent. total efficiency, to 2,400 H.P. on the turbine shafts, so that of the total available power of 3,000 H.P., two sets of turbo-alternators of 300 H.P. each or one set of 600 H.P. are used as reserve. The mileage of primary transmission is equal to 22 H.P. installed lamps and motors per kilometre, or 35 H.P. per mile. The total cost of construction, transmission, and distribution amounts to £53 8s. per H.P. The net profit amounts to 4 per cent. on the capital. Particulars are given of the charges for energy and light, cost of construction, &c.

L. J. S.

938. *Power Station, Merrill, Wis.* **F. E. Woodford.** (Amer. Electn. 11. pp. 551–553, 1899.) — Description of the generating station of the Merrill Railway and Lighting Company, which presents a unique arrangement of combined hydraulic and steam power plant. There are several turbines and generators coupled on one shaft, the machines being used for both lighting and traction purposes. The power house is built on the riverside, the flumes, which contain the wheels, being a part of the dam. Upon the rock-bed of the river are built the flume walls, which also serve as foundations for the works building. The wheels are 42 inch, of the upright type, and run at 102 r.p.m., under a head of 12 feet. Directly above the wheels an iron harness extends the full length of the building, and serves as a foundation for the electrical generators and for the yokes of the main shaft bearings. The four wheels are geared to this horizontal shaft, upon which the armatures of the generators are mounted, and which extends the full length of the building. One end of the shaft passes through the outer wall, at which end power is applied to it by the steam engine. Clutches are arranged in the shaft so that loads on generators and wheels

can be changed. The generators are of General Electric manufacture, two of 250 volts, which run in series, and one of 500 volts. A battery of accumulators is installed, and from this the lighting circuits are fed by five wires. Arc lighting machines are driven by belts from the main shaft. The steam plant is in a separate building, and is at present used only when the river is very low. It develops 250 H.P. at 90 r.p.m., and is coupled by belt to the shaft extension. The operation of the plant is exceedingly simple ; very little adjustment is necessary with the battery across the mains, one attendant only being required at any time. E. D. P.

939. *Coventry Electric Tramways.* (Elect. Rev. 46. pp. 187–190, Feb. 2, 1900.)—The chief point of interest in the equipment of these lines is a special "constant pressure" trolley standard, designed for going under low bridges without increasing the pressure on the trolley wire. The springs are all concealed in the body of the standard, and a cam makes their leverage depend on the slope of the trolley pole. On the bracket-arms, the insulators are supported by bowstrings fixed in harps. E. H. C.-H.

940. *Statistics of German Tramways.* **W. Mattersdorff.** (Elektrotechn. Ztschr. 20. pp. 885–886, 1899.)—Tabulated data and curves are given of the receipts and car-kilometres run, &c., of the following tramways :—

(1) Berlin tramways (Grosse Berliner Strassenbahn). (2) Vienna tramways. (3) Two tramway Companies, operating in Dresden. (4) Hamburg tramways.

The receipts, &c., for the last twenty years of the first-named are given in a table, part of which is reproduced.

Year.	Receipts in marks.	Car kilometres.	Pfennige per car kilometre.
1879 ...	4,530,372 ...	6,242,634 ...	72·6
1884 ...	8,710,985 ...	13,465,335 ...	64·8
1889 ...	13,218,435 ...	21,939,779 ...	60·4
1894 ...	14,700,755 ...	26,809,760 ...	55·0
1898 ...	18,612,710 ...	37,772,595 ...	49·4

E. K. S.

941. *New York Electric Conduit System.* (Street Rly. Journ. 16. pp. 15–23, Jan., 1900.)—The conversion of 29 miles of the Third Avenue Railway Co.'s main lines from cable to underground electric conduit is now completed : another 29 miles is in progress. Radical innovations in track and car construction have been introduced, and the main power station, containing 96,000 H.P., is the largest in the world.

The notable new features in the track are the use of cast-welded joints in conduit construction, the combination of steel and cast-iron yokes, the employment of a continuous creosoted stringer under the rail at all points except at special work, and the use of a spring liner between the base of the rail and its seat on the yoke. On the Third Avenue line the cable was retained till the last moment, the change of each section to the electric system being effected in twenty-four hours.

The new form of car is a 32 feet convertible car, opened or closed, of which dimensioned plans are given. The dashboards carry the controller, the sand-box handle, the air-brake handle, and the hand-brake handle. A double-pressure gauge shows the pressure in the reservoir and in the jam cylinder. A special device has been added to facilitate finding the "lap"

position of the air-brake handle. The plough differs in details from the design used by the Metropolitan Street Railway Co., but will run over that Company's tracks.

A temporary 6,000 H.P. station was erected and running within three months from the signing of the contract. (See also 1899, Abstract No. 944.)

E. H. C.-H.

942. *Kingsland's Contact System.* (Elect. Engin. 24. pp. 660–661, 1899.)—The contact plates on the track surface are connected with the feeders through two pairs of commutators coupled by sectional mains. The commutators are carried on the spindle of a four-point star, fixed below a slot formed by a guard-rail outside the track-rail. A striker on the car revolves each pair of commutators through a quarter turn when it passes the star wheel. The arrangement of contacts is such that when one of the sectional mains between two pairs of commutators is connected to the feeder at one end, it is insulated at the other, while its fellow is disconnected from the feeder. The system is to be tried on an experimental line at Wolverhampton. E. H. C.-H.

943. *Cure of Electrolysis by Independent Earth Returns.* **C. A. Newbaker.** (Amer. Electn. 12. pp. 72–74, Feb., 1900.)—The streets of large cities are particularly favourable to electrolytic action on lines of metal laid under them, because the ground contains a large accumulation of impurities which form acids and alkalies for electrolytes. Lead has a high electrochemical equivalent: that is, a large amount of it is dissolved per ampere hour of current flowing from it, and therefore unfavourable earth conditions cause its rapid decomposition.

A peculiarity of electrolytic action is that no metal is dissolved where the current flows into a pipe, but all metals are liable to be attacked by current leaving the pipe and flowing into the material surrounding it. On account of this and the fact that the positive pole of the dynamos is to line, the tendency is to localise all the trouble in the district near the power house.

The independent return method of curing electrolysis consists in running metallic connections from all underground piping, cable sheathing, &c., to the return circuit of the traction system at all *points where the current tends to leave the piping and return to the traction circuit.* Current leaving the pipes *viâ* a metal path does no harm, and as the current entering the pipes is also harmless, this method, where thoroughly carried out, is a very satisfactory one. The return should be of stranded copper (tinned) connected to lead cable sheath by means of a looped joint and to the tram rails either by a soldered joint to a cross bond or by a separate bond to the track itself.

Thorough tests should be made for electrolysis at intervals of six months or oftener if changes in the conditions of distributing power are known to have occurred. A telephone company, for example, may at one time make tests and find that its system is, on the whole, safe, and a little later find that a highly dangerous condition exists. This sudden change may be due to a lowering of the potential of the ground below that of the track by auxiliary returns run by some other corporation operating over the same territory, such as a water or a gas company. This is a condition to be watched for at all times, as the protection of one set of pipes is likely to cause danger to another.

The author describes a method of making systematic tests and how to plot curves showing the distribution of potential over a piping system and adjacent ground before and after using an independent return, &c. The edges of the hole burned into the cable sheath by a heavy current are square as though

the hole were punched out, whereas the edges of a hole made by electrolysis are thin like those of a dull knife-blade. Electrolysis always causes grainy, rough surfaces, and its apparently freakish tendency to attack in spots and form ridges is probably due to a lack of homogeneity in the metal.

The current in a return may be read by a milli-voltmeter giving the voltage between two points a few feet apart, the current being calculated on the basis of 10 ohms per foot per circular mil. This obviates the necessity of cutting the return to insert an ammeter. E. K. S.

944. *Trolley-Wire Guards.* **Moens.** (Assoc. Ing. Él. Liège, Bull. 10. pp. 259–264, 1899.)—Trolley-wires are divided into two classes: those which merely prevent contact with the trolley-wire, such as insulated guard-wires, insulated trolley-wire coverings, &c.; and those which earth the trolley-wire when contact is made. In all cases telegraph and telephone circuits should be protected by fuses which blow at 0·1 to 0·2 amperes. Ulbricht has devised a system to avoid the dangers attendant on the guard-wire coming in contact with the trolley-wire. The former is earthed through the coil of an electro-magnet actuating a switch which earths the trolley-wire direct and thus opens the station cut-outs. L. B.

945. *Trolley-Wire Guards.* **Pedriali** and **d'Hoop.** (Assoc. Ing. Él. Liège, Bull. 10. pp. 302–309, Jan., 1900.)—Trolley-wires may be protected from falling telegraph- or telephone-wires either by guard-wires or by an insulating covering on the upper surface of the trolley-wire itself. Guard-wires are comparatively complicated, unsightly, costly, and dangerous, and in many towns, particularly in Germany, are being replaced by a strip of insulating material clipping the upper part of the trolley-wire. L. B.

946. *Trucks for Electric Tramways.* **G. Dary.** (Électricien, 18. pp. 363-366, 1899.)—A description of three models of the Baltimore trucks, the first being the maximum traction bogie type with small and large wheels. The second is an extra long car truck, and the third a bogie truck for heavy cars. The frames are of very neat design of flanged pressed steel with cast steel axle-boxes. Particulars are given of the methods of spring suspension. E. K. S.

947. *Recent Experience in Rail-bonding.* **H. P. Brown.** (Eng. News, 42. p. 239, 1899. Abstract of a paper read at the Toronto Meeting of the American Society of Municipal Improvements.)—Two years ago copper wire riveted into the rail was abandoned in favour of short flexible "leaf" bonds, generally placed under the fishplates. The ends of the bonds were brazed or cast into lugs, which were expanded into the rail holes either by screw pressure or by taper plugs. Tests have shown that screw-compressed terminals turn when the weight at the end of an 18-inch lever arm reaches 143 lbs.; with taper steel plugs 65 lbs. turns the bond. The latter are, however, found best, as the poor mechanical joint prevents the severe mechanical strain on the copper wires which is found to cause crystallisation and breakage of the screw-compressed bonds. A promising new bond consists of a solid copper bar, $\frac{1}{8}'' \times 3'' \times 2''$, having a projecting contact cup pressed on each end. The bond is placed under the fishplate, and is held against the rails by a strong steel spring in each cup.

In Indianapolis, where the power-house output is 2,800 amperes, the water

pipes are carrying 1,400 amperes with a maximum positive pressure of 8·2 volts. These measurements were made since the installation of cast-weld joints; previously the maximum positive pressure was only 6·8 volts, and the "dangerous" area for pipes was only half what it now is. The author advocates the introduction of iron-banded wooden pipes at intervals in the water mains. E. H. C.-H.

948. *German Electric Automobiles.* (Elect. World and Engineer, 34. pp. 692–693, 1899.)—A primary battery motor-car is described. The plates are zinc and lead peroxide, the latter of which is charged and loaded with acid. The battery for a 40-mile run only weighs 42 lbs. Another motor-car has a small battery of accumulators, an electric motor, and a petrol engine which receives electrical assistance on heavy gradients and on starting, but normally charges the cells. The weight is less than an accumulator-driven car, and the cost £240. An electric accumulator omnibus running in Berlin is described. M. O'G.

949. *Electric Automobiles.* **E. A. Sperry.** (Amer. Inst. Elect. Engin., Trans. 16. pp. 533–549. Discussion, pp. 549–551, 1899.)—The author found that the amount of side-thrust transmitted to either guide-wheel of his motor-car is proportional to the distance between the steering axis and the plane of the wheel at the height of the obstruction. He therefore designed a gear with its steering axis intersecting the plane of the wheel some distance above the ground, and found that obstructions which caused a lateral pull of 10 lbs. on an ordinary steering handle gave no pull on the handle of his gear. Another result of the obliquity of the steering axis is that the vehicle tends to run straight forward if not guided. For automobiles, the best tramway practice can be followed in the main, but the motor may have an increased ratio of copper to iron. A compound adjustable gear is an advantage for emergencies and saves the battery. Double-reduction gear permits the use of a powerful brake on the intermediate shaft and of a higher speed bi-polar motor, which is slightly more efficient than a multi-polar. Efficiency is all-important in an automobile because the source of power is not at hand. The author recommends the use of a single handle, whose direction should indicate the direction of the vehicle's motion, speed being regulated by raising and lowering the handle, which operation applies the brakes automatically. For charging batteries, the differential wattmeter system is advised. E. H. C.-H.

950. *Working Expenses of Horse and Electric Delivery Vans.* **G. F. Sever** and **R. A. Fliess.** (Amer. Inst. Elect. Engin., Trans. 16. pp. 509–531, 1899.)—This paper sets forth the results of an investigation on horse and electric vans belonging to large stores in New York. Their average load throughout the day is 500 lbs., and the average "draw-bar pull" at 7 miles per hour is 60 lbs. per ton on cobblestones; on asphalte, 40 lbs. The van tested weighed 1,300 lbs., and its horse 1,100 lbs. A day's "log" of a van is given, from which it appears that the average daily work of a horse in such service is 16·5 miles at 50 lbs. per ton at 7 miles per hour, while the cost of horse, van, and attendance is 864 cents per day, or 17·4 cents per ton-mile. If a second horse is kept, these figures respectively become 428 cents per day and 10·2 cents per ton-mile.

A similar "log" for an electric delivery van is given, and shows an average consumption of 92 watt-hours per ton-mile. The authors are of

opinion that 120 watt-hours per ton-mile is a conservative estimate for a well-designed delivery van under service conditions. At 5 cents per kw. hour, the cost per lb. (of parcels only) is 0·019 cents, as against 0·020 cents for horse service, making all assumptions in favour of the horse. Depreciation is not taken into account in any of the figures. E. H. C.-H.

951. *Electric Automobile.* (Automotor Journal, 4. pp. 163–164, Jan., 1900. Adapted from an article by A. Delaselle in La Locomotion Automobile.)—Two four-pole motors are used with armatures vertical, and the motor frames resting directly on the axles of the fore-wheels. The steering is ingeniously effected by pivoting the short steering axles on the centre lines of the driving pinions. M. O'G.

952. *Traction Accumulator Trials.* **A. Bainville.** (Électricien, 18. pp. 161–163, and 329–332, 1899; see also Abstract No. 403, 1900.)—It was not foreseen in the rules that certain batteries would become reversed during the variable discharges before being brought up for the constant rate trials in which they are eliminated. Hence in comparing cells from the published results their merits must be measured by the watt-hours given off, and not by the number of variable discharges they have been submitted to. The shaking test was frequently omitted, owing to breakdowns of the apparatus. M. O'G.

953. *Traction Accumulator Trials.* **A. Bainville.** (Électricien, 18. pp. 398–400, 1899.)—The French Automobile Club trials are summarised as follows:—

Number.	Names of Competitors.	Total Weight.	Total Output. Watt-hours.
		Kg.	
1 F	Société anonyme pour le travail électrique des métaux. Paris	104	764
2 L	Compagnie générale électrique. Nancy. "Pollak" plates	119·5	795
3 K	Société Tudor. Paris, Bruxelles, and London	125·7	1,358
8 Q	Lagarde. Paris	89	363
9 E	Wuste et Rupprecht. Vienna (Austria)	70·25	145
11 N	Société de l'accumulateur Fulmen. Clichy	76·5	1,022
13 I	" " "	83	318
17 P	Société des soudières électrolytiques. Gavet-Clavaux (Isère)	77·5	446
18 J	Franz-Heimel. Vienna (Austria)	59·5	360
19 M	W. Pope and Son. Slough (England). "Sherrin" plates	86·3	375

M. O'G.

954. *Traction Accumulator Trials.* **É. Hospitalier.** (Électricien, 19. pp. 20–26, Jan. 13, 1900.)—This complete summary of particulars of the eight best cells shows the weights of plates, liquid, cases, total energy taken in and put out, &c., by the cells before they failed in the trials by the French Automobile Club. Thus the *total energy given out in watt-hours,* divided by the total weights in kgs., is as follows: Metaux, 9·7; Pollak, 8·8; Tudor, 8·9; Pescetto, 8·7; Blot Fulmen, 9·8; Fulmen, 15; Phœnix, 12·5; Pope-Sherrin, 11·5.

The data enable the cells to be very well compared. M. O'G.

955. *Series Arc Lighting from Constant Current Transformers.* **W. L. Robb.** (Amer. Inst. Elect. Engin., Trans. 16. pp. 557–564. Discussion, pp. 565–578, Nov., 1899.)—The author refers to the various methods which have been adopted for operating series arc lamps from alternating current systems. In several well-known stations in the United States continuous current series arc dynamos are driven by synchronous or induction alternating current motors. Before deciding on the system described in this paper and in use at Hartford, consideration was given to the above system and to the use of rectifiers.

The development of the enclosed arc lamp quickly led to the evolution of a satisfactory alternating arc lamp of the constant potential variety, and experiments were carried out for operating these lamps from the constant current transformer, which formed one of the essential parts of the rectifier.

These experiments proved quite satisfactory, which led to the replacing of all the continuous current series arc dynamos by constant current transformers, with a view to obtaining a greater economy of operation.

Each transformer is immersed in transil oil and is contained in a cast-iron tank. The core of the transformer is placed vertically and rises the whole height of the tank. The core is surrounded by the primary and secondary coils, and the magnetic circuit is closed by return paths outside the coils. There are two primary and two secondary coils, and one of the primaries is fixed at the bottom and the other at the top of the central core. The two secondaries are free to move up and down between the primary coils, and are so connected together that when one falls the other rises. The coils are balanced by a system of chains, levers, and counterweights. When the transformer is in operation the currents induced in the secondary react on those in the primary and tend to force the coils apart. This force is balanced for the desired normal current by the adjustable weight outside the case.

The principle of regulation was first suggested by Elihu Thomson, and its application to the operation of constant current transformers is broadly patented by him.

By bringing out the proper connections from the secondaries the total number of lights may be operated as a single circuit, or operated in any desired number of multi-circuits in a manner similar to the well-known method employed on the Brush series dynamos of large capacity.

Owing to the high voltage of the enclosed arc lamp the 100-light transformers usually operate two circuits connected upon the multi-circuit principle.

The transformer can be adjusted so as to give practically a constant current between one-third load and full load. Curves are given showing the range of regulation that can be obtained by means of the adjustment provided.

Tests showed that when the transformers were adjusted to give a constant current through any desired range of load, that the lamps would draw different lengths on the arcs depending on the number of lamps on the circuit. The voltage across the terminals of the individual lamps was approximately 10 volts higher at one-fourth load than at full load, although the current was the same in both cases. It has been found, however, that by varying the adjustment of the transformer, it is possible to adjust it so that the voltage across the terminals of the individual lamps remains practically constant at various loads. If so adjusted, however, the current from the transformer is no longer constant but increases as the load increases.

The averages of tests made on two 100-light transformers were as follows :—

Load.	Efficiency.	Power Factor.
¼	88·1	24 per cent.
½	92·3	44 ,,
¾	94·9	62 ,,
Full	96·1	78 ,,

The rise in temperature of the oil of the transformer measured at the top of the iron core, where it was highest, was 39° C. after a twenty-four hours' run.

The low power factor at small loads and difficulty in maintaining the lamps at constant voltage when the current is constant at various loads, combine to make the constant current transformer undesirable except when the conditions are such that it is possible to operate the transformer under a large part of its rated full load. It has been found in practice that the transformers can be maintained and operated successfully with very little attention.

The primaries of the transformers are connected across the 2,400-volt alternating current feeders. Although the voltage at the terminals of the primary of the transformer is subject to a variation of 5 per cent. during street-lighting hours, the current supplied to the series lighting circuits is practically constant.

The lamps operated from the constant current transformers are of the carbon feed enclosed type. The frequency is 60. The lamps used in Hartford consume at the transformer 400 watts per lamp, and replaced nominal 1,200 c.p. open-air direct current arcs. The streets are undoubtedly better lighted with series enclosed arc lamps than they were formerly with the open-air arcs. The power required under the local Hartford conditions for operating street lights has been reduced in the ratio of 550 to 400 watts, or a little over 27 per cent.

The author concludes with the statement that the system of street lighting which will be found best for any given city depends largely upon the local conditions ; but there are undoubtedly many cases where an investigation will show that the adoption of the constant current transformer and the series alternating current arc lamp offers the greatest advantages.

The paper is followed by a lengthy discussion. L. J. S.

956. *Lacko's Arc Lamp.* (Elekt. Runds. 17. pp. 54–55, Dec. 15, 1899.)—This lamp is due to D. Lacko of Paris, and comprises a worm-wheel which gears at opposite sides with racks bearing the carbon-holders at their lower ends. On the same axis as the worm-wheel there is also mounted an oscillating frame on which are pivoted two auxiliary frames. The first of these frames carries the worm-shaft and is provided with an armature acted upon by a solenoid in the main circuit, a spring being provided for holding the frame in such a position that the worm is out of engagement with the worm-wheel when there is no current flowing through the lamp. The second auxiliary frame bears a feed-pawl adapted to engage with a ratchet-wheel on the worm-shaft, a spring being arranged to act on the frame in opposition to the pull of the shunt electromagnet on an armature attached to the frame. This second frame is also provided with an adjustable set-screw which, when the armature on the frame has been drawn down and the worm has been rotated by the ratchet-wheel and pawl, breaks the circuit of the shunt electromagnet and allows the spring to return the frame to its normal position ready to again rotate the worm through a similar angle. In starting the lamp, the series electromagnet attracts the armature on the first

auxiliary frame so as to bring the worm into engagement with the worm-wheel, and then cause the main frame to oscillate so as to strike the arc. When the shunt electromagnet becomes stronger, by reason of the rise of potential during the burning away of the carbons, the second auxiliary frame is drawn down against the tension of its spring and the worm rotated through the feed-pawl; when this frame has reached the end of its travel it returns to its normal position as above mentioned, and so on. The original paper is illustrated. C. K. F.

957. *High-voltage Lamps.* (Electrician, 44. pp. 118–119, Nov. 17, and 153–155, Nov. 24, 1899.)—In the first part of this paper are given illustrations of lamps from the various makers showing the shape of filament and type of lamp. In the second part are shown curves of the c.p. and watts per c.p. The first curve gives a typical efficiency curve, taken by a leading English lamp manufacturer on a circuit occasionally exceeding the normal voltage by 4 per cent.; the watts per c.p. start at 3·7 and fall to 3·6 in the first 100 hours, then increase to 4·3 in a 1,000 hours. Various other life-curves are also given.

Robertson recommends an efficiency of 4 watts per candle for 16 c.p. lamps of high voltage, and that this figure should be allowed to increase somewhat, say to 4·5 watts per candle, for candle-powers of 8 and less. Stearn states that about 80 per cent. of the lamps he manufactures are for voltages of 200 and over. The Sunbeam Company choose as their standard efficiency 3·75 watts per c.p. for 16, 25, and 32 c.p. lamps, but for 8 c.p. lamps do not recommend a higher efficiency than 4 watts per c.p. They have found in their own testing-rooms that such lamps have practically as good a life-curve as an ordinary low-voltage lamp, and that the efficiency is certainly well maintained in a 500 or 600 hours' run with a drop of not more than 3·5 candles, at which point, of course, consumers should renew their lamps. Smaller lamps than 8 c.p. have not such a good efficiency. To be satisfactory a 5 c.p. lamp requires some 4·5 to 4·75 watts per c.p. The Berrenberg Company promise great things as regards efficiency, promising 2 and 2·5 watts per c.p. for 16 c.p. and 8 c.p. lamps over a fairly long life. Goossens, Pope & Co. make their standard lamps of the following efficiencies: 5 c.p., 4·5 watts per c.p.; 8 c.p., 4 watts per c.p.; 16, 25, and 32 c.p., 3·5 watts per c.p.; 50 and 100 c.p., 3·3 watts per c.p.

The Electric "Tested Lamp" Co. give curves of a good English 200 volt 16 c.p. lamp, and also of a bad one of the same voltage and c.p. In the first the c.p. starts at 15·6, rises to 17·4 in 96 hours, and then falls to 16 in 576 hours, after which it falls very rapidly. The corresponding watts per c.p. are 3·9, 3·7, and 4. In the case of the bad lamp the corresponding figures are: c.p., 14·8, 19·8, and 11·6; watts per c.p., 4·2, 3·6, and 5·8. They also give a curve of a bad Austrian lamp, which is still worse. Mention is made of a device of A. G. Seaman, brought out by the "Tested Lamp" Co., for an automatically adjusted rheostat connected to a voltmeter relay, which is intended to be placed between the supply mains and the consumer's distribution board to prevent the over-running of lamps.

Attention is drawn to the difference between the English standard candle and the Hefner amyl-acetate standard, as some English makers employ the latter in rating their lamps. A 16 c.p. lamp, if named according to the Hefner unit, would give only about 14 candle English standard power, and a lamp requiring 3·5 watts per Hefner standard required nearly 4 watts per English standard. E. C. R.

958. *Scientific Principles of Arc Lighting.* **F. W. Carter.** (Elect. Rev. 45. pp. 994–995, Dec. 22, and 1034–1037, Dec. 29, 1899.)—The author obtains expressions for the total illumination, the horizontal illumination, and the vertical illumination, at any point due to an elevated source of light considered as a geometrical point. These expressions are respectively $I \cos^2\delta/(h - h^1)^2$, $I \cos^3\delta/(h - h^1)^2$, and $I \cos^2\delta \sin \delta/(h - h^1)^2$, where I is the candle-power of the source in the direction of the point considered, δ is the inclination of this direction to the vertical, h is the height of the source above the ground, and h^1 is the height of the point considered. From these expressions the author gives a geometrical construction for finding polar and cartesian curves for these three illuminations when the photometric curve of the source is given. The theory is extended to the combined effect of two or more independent sources of light. W. G. R.

959. *Electric Train Lighting.* **H. Massenbach.** (Elektrotechn. Ztschr. 21. pp. 50–52, Jan. 11, 1900. Paper read before the Elektrotechn. Gesellschaft, Frankfurt-a-M., Dec. 6, 1899.)—The general advantages of electric train lighting are described and details are given of the system developed by Vicarino. This closely resembles that used by the Electric Axle Light and Power Co. of New York, under Moskowitz's patents (see 1900, Abstract No. 779). A dynamo is placed under each car driven by leather-faced friction wheels from the axle. The voltage is kept constant by a reversed compound winding. The battery and automatic switching and regulating devices are described. Photometric comparisons between gas and electric lighting are given and detailed estimates of cost under each system. This amounts to 0·28d. per 10 c.p. lamp hour for gas against 0·21d. per 12 c.p. lamp hour for electric lighting. L. B.

960. *Electric Train Lighting.* (Elect. World and Engineer, 34. pp. 867–869, Dec. 2, 1899.)—An illustrated description of the method employed by the Electric Axle Light and Power Co. of New York. A 40-volt dynamo is geared by friction wheels to an axle of each car, the pinion having a fibre face. This charges a battery carried under the car body. The automatic switches for connecting the dynamo to the circuit when the speed is high enough, disconnecting when the speed falls, and reversing when the car is required to run in the opposite direction, are mentioned but not described. L. B.

REFERENCES.

961. *Railway Drawbridge in Boston.* (Street Rly. Journ. 16. pp. 37–38, Jan., 1900.)

962. *Subway at Kingston, U.S.A.* (Street Rly. Journ. 15. pp. 861–864, Dec., 1899.)—Description of a subway at Kingston, N.Y., for trolley cars, beneath the West Shore Railroad tracks.

963. *Electricity in Powder Works.* **W. H. Allen.** (Elect. World and Engineer, 34. pp. 733–735, Nov. 11, 1899.)—An illustrated article dealing with the electrical equipment, for both lighting and power, of the Californian Powder Works. E. D. P.

964. *Third-rail Conductors for Electric Railways.* **L. Daft.** (Cassier, 17. pp. 235–239, Jan., 1900.)—The paper contains drawings showing the design and construction of third-rail conductors, together with insulators for supporting them.

965. *Electrical Power for Drainage, New Orleans.* **L. C. Reed.** (Elect. World and Engineer, 34. pp. 771–775, Nov. 18, 1899.)—The various and widely scattered pumping stations of this scheme are operated by three-phase currents transmitted from a main generating station. A general description of the system is given. E. D. P.

966. *Bromley and Chislehurst Electric Lighting.* (Electrician, 44, pp. 462–467, Jan. 26, 1900.)—The high-pressure direct-current system is used. Power is transmitted at 2,000 volts pressure from the generating station at Bromley to a substation of direct-current transformers and batteries at Chislehurst, a distance of $2\frac{3}{4}$ miles. A full description of the system is given, with illustrations. E. D. P.

967. *Bolton Electricity Works.* (Elect. Rev. 46. pp. 101–105, Jan. 19, 1900.)—A fully-illustrated description of these large works, in which power is generated for both traction and lighting purposes ; also some particulars of the outdoor construction in connection with the trolley tramway scheme. E. D. P.

968. *Electricity Works at Bonn.* **P. Bauer.** (Elektrotechn. Ztschr. 20. pp. 850–856, 1899.)—A full description of the electric light station equipped by Siemens & Halske on the continuous current three-wire system with accumulators, and 440 volts across the outers. The dynamos are of the Gramme multipolar type, with the armature revolving outside the poles. E. K. S.

969. *High Tension Transmission in the United States.* **C. E. Guye.** (Écl. Électr. 21. pp. 241–249, 452–456, and 487–491, 1899.)—Description of some transformers (pp. 241–249). Testing the Telluride line (pp. 452–456). High tension experiments at East Pittsburg (pp. 487–491).

970. *Transmission of Energy by Alternating Currents.* **M. Leblanc.** (Soc. Int. Élect., Bull. 15. pp. 416–460, 1898, 16. pp. 54–102, 112–159, 316–344, and 349–385, 1899.)—Series of papers similar to those referred to in Abstract No. 749 (1900).

971. *Electrical Distribution.* **C. F. Guilbert.** ((Écl. Électr. 19. pp. 281–289, 401–410, 1899, 22. pp. 13–21, Jan. 6, 1900.)—Appliances described of Thomson-Houston, Steinmetz, Schuckert & Co., for Alternate Current Distribution (pp. 281–289). Description of System of Direct Current Distribution, patent by Bliss (pp. 401–410). Also various patent devices in connection with the distribution of energy ; among others, methods due to C. F. Scott, to the Westinghouse Company, the Electric Construction Company, Thomson-Houston Company, and to Messrs. Verity & Steele are dealt with (pp. 13–21).

972. *Aluminium Feeders on the North-Western Elevated Railroad, Chicago.* (Amer. Electn. 12. pp. 20–23, Jan., 1900.)—An article describing and illustrating the methods adopted in laying some large bare aluminium feeders.

973. *Third Avenue Railroad Power Station, New York.* (Street Rly. Journ. 16. pp. 1–12, Jan., 1900.)—A full description of the large new works which the Third Avenue Railroad Company of New York are about to erect, dealing more particularly with the works structure and the steam plant, about 100,000 H.P., which it is proposed to instal. (See 1899, Abstract No. 944.) E. D. P.

974. *Distribution of the Energy of Coal in the Working of Electric Traction.* **A. B. Herrick.** (Street Rly. Journ. 16. pp. 12–14, Jan., 1900.)—The author splits up the working of electric traction into many parts, and deals with the losses taking place and the possible economies to be obtained in each. A coloured chart is included, which shows graphically the magnitude of the various losses in street railway operation ; the losses are divided up very completely, eighty-nine sections being represented on the chart. E. D. P.

TELEGRAPHY AND TELEPHONY.

975. *Wireless Telegraph Patents.* (Electrician, 43. pp. 847–850, 1899.)—Marconi has applied for eight patents since No. 12,039 of 1896. (See Electrician, Sept. 17, 1897.) No. 29,306 of 1897 provides for an automatic shutter closing the box which protects the coherer when the transmitter is used. No. 12,325, June 1, 1898, deals with the iron enclosure of the receiver. No. 12,326 of June 1, 1898, describes how the tall-wire is connected to earth not through the coherer but through the primary of a coil, of which the secondary is wound in such a way that the number of turns in each layer is diminished as the distance from the primary increases. It is stated that "the effect of the oscillations on the imperfect contact increases greatly with their E.M.F. and not with their quantity." Full dimensions are given as a guide to constructing the apparatus. The special coils are described in No. 6,982, April 1, 1899. O. Lodge's patent, No. 11,575, of May 10, 1897, describes the use of a coil with its primary between the receiving wire and earth. M. O'G.

976. *Wireless Telegraph Repeater.* (Elect. Rev. 45. pp. 749–750, 1899.)—Foresio's instrument can be used as transmitter, receiver or repeater by a three-way key. A coherer is made to actuate the induction coil. It is proposed to use a metal partition between the receiving tall-wire and the retransmitting wire, and so keep the effects distinct. Two such apparatuses are required to retransmit in both directions. M. O'G.

977. *Wireless Telegraphy Without a Coherer.* (Elect. Rev. 45. pp. 1026–1027, 1899.)—W. B. Starkey uses a pivoted needle of silver strip, having one end in proximity to the receiving vertical wire; this needle moves into contact with the vertical wire with sufficient force to close a local bell circuit. With aërial conductors 8 feet high the talking distance was 36 feet. M. O'G.

978. *Dardeau's Telephonic System.* **E. Piérard.** (Électricien, 18. pp. 409–412, and 426–429, 1899.)—This is a system by which any two or larger number of stations can inter-communicate upon one common circuit. There are two keys and an Ader relay in the line circuit in each office. When key A, say, is pressed at any office the tongues of the relays in all the offices move to the left, and by means of an electromagnet in a local circuit cause a needle to indicate upon a dial in each office that a call is being made. Each time now that key B is pressed the needle moves one step further over the dial to point the number of the station wanted, the tongues of the relays being now in contact to the right. A cam fixed appropriately to a small wheel engaging with the step-by-step toothed gear, and at a different angle for each station, closes a local circuit and causes the bell to ring in the station called by coming over to its proper position after the requisite number of depressions of key B. The bells in the other stations are not then actuated. At the same time the armature of a second electromagnet in these stations is held over, and cuts their telephones and keys out of circuit. After a conversation is finished, the positions of the needles at all the stations having meanwhile intimated that the circuit is engaged, the key B at either of the two stations that have been in communication is pressed as many times as necessary to bring back

all the needles to their positions of rest. If a third office is required to be called while the first and second are in communication, means are afforded by which the second station can, by signalling the correct number of times, unlock the armature of the station required and ring its bell by moving over the little cam referred to above.

There is one stop upon the dial in each office marked "General Call." It is situated at the end of the series of numbers, and any station actuating the calling key B a sufficient number of times to bring the needle to this position can cause the bells in all the stations to ring, and open all short-circuited armatures, thus permitting of general conversation. E. O. W.

979. *Protecting Telephones.* (Elect. Rev. N.Y. 35. p. 249, 1899.)—An infusible non-inductive heat coil is used to ground foreign currents and restore the telephone line automatically as soon as the line is open at the cable-box. The rack of heat coils makes a useful board for either testing to the switchboard or lines. Larger fuse-wire is possible with this system. M. O'G.

980. *Five Subscribers on One Telephone Line.* **J. H. West.** (Electrician, 44. pp. 496–498, Feb. 2, 1900; see 1899, Abstract No. 1832.)—The subscribers cannot overhear or interrupt one another; each one is rung up from the exchange individually. M. O'G.

981. *Telephone Switch-room Sundries.* (Amer. Electn. 11. pp. 410–412, 1899.)—The Lafayette Telephone Company, Indiana, has eleven 100-drop sections of switchboard, and details as follows: The 500 ohm drops have their armatures in the middle of the spool which is also enclosed in a Norway iron core-shield. The jacks are held in place in the jack-board by a lock-nut, placing the jack in from the rear of the board and the lock-nut from the face. Ringing and listening keys are placed in dust-proof jackets. The Beach-Cook automatic transfer system which is open to telephone companies independent of the Bell Company is explained with diagrams. All detail parts are illustrated. M. O'G.

REFERENCES.

982. *Simultaneous Telegraph and Telephone and Duplexing.* **T. D. Lockwood.** (Elect. Rev., N.Y., 35. pp. 216–218, 1899. Paper read at the Wilmington meeting of the Association of Railway Telegraph Superintendents.)—Descriptions are given of elementary methods and of Van Rysselberg's system. References are made to Jacob's U.S. patent, No. 287,288, October 23, 1883; to Van Rysselberghe's, No. 323,239, July 28, 1885; and to Black & Rosebrugh's, No. 212,433. M O'G.

983. *Telephone Exchange: New Common Battery System at Brooklyn.* (Elect. World and Engineer, 34. pp. 963–966, 1899.)—General description of exchange and system, variety of lines and rates detailed, and respective symbols on indicator lamps illustrated. J. E. K.

984. *Portable Telephone for Speaking on Fire Alarm Wires.* (Elect. World and Engineer, 34. pp. 715–716, 1899.)—A small instrument without signalling device is described which uses the ground as return wire by means of a condenser, and which can be connected in when a street fire alarm is used. M. O'G.